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ABSTRACT

The papers include discussions on (1) training techniques for safety administrators; (2) materials and services from the National Safety Council; (3) fire safety measures; (4) high-rise buildings; (5) the role of the industrial hygienist in environmental health and safety; (6) chemical waste disposal facilities; (7) a chemistry department safety program; (8) safety programs of a federal agency on a university campus; (9) a situational approach to loss control; (10) portable combustible and toxic gas indicators and alarms; and (11) gas detection on campus. (Author/KE)

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SAFETY MONOGRAPHS FOR
SCHOOLS AND COLLEGES

THE UNIVERSITY
OF CALGARY

MONOGRAPH NO. 35

TWENTY-SECOND NATIONAL CONFERENCE on CAMPUS SAFETY

U S DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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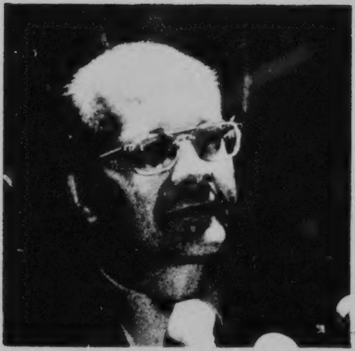

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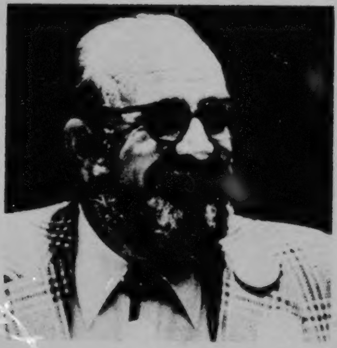

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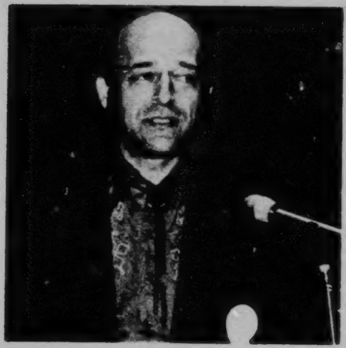

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TRAINING TECHNIQUES FOR THE SAFETY ADMINISTRATOR

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It is commonly known in the medical profession that the doctor does not save all the patients. By the same token, it has probably been said that the trainer does not train all the trainees, or at least not effectively. Training effectiveness could be seriously debated and, among various items, depends upon the subject, the trainer, and the techniques utilized.

This presentation will explore various Training Techniques which can be effectively utilized by the Safety Administrator.

At the outset, so we are all on the same wavelength, two terms should be defined. They are training and techniques.

Training may be thought of as transmitting specific skills, often motor skills, to the trainee and guiding the practice of these skills to an acceptable level of performance.

Techniques are the methods of procedure essential to execution of any art, science, etc. to include methods of training.

Some preliminary activities need be addressed before giving serious thought to training techniques. There are three recognized means of determining if a need or requirement for safety and occupational health training exists.

1. Analyze the organization's accident experience or performance to determine if an adverse trend is present indicating a possible need for training.

2. Compare training requirements with activities and environments to determine if a legal requirement for training exists.

3. Conduct a training needs survey to identify those areas or activities in which training is desirable.

We must determine training needs and requirements for various reasons:

1. So people will be more productive and work safer in their present jobs.

2. Because the success of the enterprise requires that everyone perform at their optimum level in a safe work environment.

3. Because all people, regardless of organizational level, can do a good job, want to do a good job, and will do a good job if they are given an opportunity. This opportunity comes in part through providing for an individual to improve his knowledge, skills, and attitudes.

4. Because time, money, and effort can be wasted through training that is not based upon valid present or emerging needs or requirements.

Basically, training needs may be determined by finding out what is presently going on and matching this against what should go on, now or in the future. The gap, if any, gives the clues to the kind and amount of training needed.

The "finding out" tool is the standard of performance for the task or job. This is a statement, preferably written, describing the conditions which will exist when the job or task is being properly performed.

Every job has a standard. However, this standard is often only floating around in the boss's head. Fortunate are the subordinates who have at least been told what this standard is. Truly fortunate are those who actually have been given a copy of the standard. Their supervisor was astute, intelligent, and persevering enough to reduce the standard to writing, which is not an easy task. Where no written standard exists, there may, in fact, be two standards: the one the boss has floating around in his head, and the one the subordinate has floating around in his head. These standards may not be the same -- a shame indeed.

The standards for performing a job often can be expressed in terms lending themselves to discrete measurement.

Training needs may be categorized in terms of those which:

An individual has

A group has

Must be met immediately

Can be met in the future

Call for formal training activities

Call for informal training activities

Call for on-the-job instruction

Call for off-the-job instruction

The organization can meet best within itself

The organization can meet best through outside resources

An individual can meet in concert with others

An individual can meet only by himself

Are legally required

There are many methods to determine training needs. Each has its advantages and disadvantages. Each can be tailored to meet a specific situation. Also, various methods can be utilized singly or in combination. Some of the more prevalent methods include:

1. An Analysis of an Activity, Process, Job, or Operation.

   One way to increase productivity and employee safety is to keep to a minimum the number of steps which must be taken to produce a product or service, then make sure each step is handled with the least amount of time, effort, and money. The procedure is simple:

   A. List as steps in a logical sequence the activities involved in producing a product or service, or part thereof. This calls for great attention to detail. Don't miss a single work movement or storage point.

   B. Question each step ruthlessly. Is the step still necessary? Can it be combined with another? Can it be simplified? Is a new or safer machine or less expensive material or a new or safer process or procedure available? Under the impact of the creativeness of those concerned, what activity can change from time to time? These changes can produce training needs. What new knowledge or skill is called for? Should present knowledge or skill be modified? If so, to what extent, when, and by whom?

2. A second method is through An Analysis of Equipment.

   A new piece of equipment or modification of present equipment may call for a new skill, knowledge, or understanding on the part of the supervisors or operators. Therefore, it becomes essential to answer these questions:

A. In what ways will the new or present equipment be different?

B. What new skills or knowledge will be necessary?

C. Who will need it?

D. When will they need it?

E. What new attitudes may be desirable for all concerned?

The answers to these and related questions will provide clues to training needs.

3. A third method is the Analysis of Problems.

Clues to training needs may come from an analysis of an operating problem. The problem may have emerged in part because an individual or group lacked knowledge, skill, or understanding to handle a specific challenge at a given moment in a specific situation. To analyze a problem for training purposes, one must ask questions. Among the best questions are the faithful six: What, Why, Who, When, Where, and How. What exactly is the problem? Why is it a problem? Who is involved? When was it triggered? What kind of knowledge or skill was missing? What should be done so that the problem, or one similar, can be handled properly if it reappears? Who should get additional knowledge, skill, or insight? When should they get it? Who should give it to them? Where should it be given? How should it be given? What kind of follow-up should be conducted?

When analyzing a problem for training purposes, the thinking and suggestions of others can be helpful and should be sought. It is insurance for you and can increase the value of the eventual solution. However, in the final analysis, weigh all ideas carefully, for training may not be the best solution in a given situation, even though some of the people involved may feel it is. Instead, better day-to-day supervision on the job, for instance, may be the answer.

4. A fourth method is an Analysis of Behavior.

Training needs clues can come from an analysis of a typical behavior by individuals or groups. Chronic absence, spoilage of work, frequent accidents, irritability, resistance to instruction, etc. are symptoms of conditions which may call for corrective action involving training. For instance, a supervisor may need to be more familiar with his safety responsibilities. An individual or a group may need to know more about the safe execution of a procedure or the health hazards of a specific work environment.

5. A fifth method of determining training needs can be through an analysis of an organization.

   Poor organization can adversely affect individual and group performance. Failure to meet goals, confused planning, sloppy delegating, weak discipline, capricious rewarding, unclear directions, absence of performance standards, uneven work load, etc. can lead to low morale, marginal performance, and an increase in accidents. Note that the presence of these or other weaknesses can produce some of the patterns of individual or group behavior mentioned above. An analysis of these weaknesses can produce clues to training needs of both individuals and groups.

6. A sixth method is an Appraisal of Performance.

   Performance appraisal is really a continual activity. The boss appraises his subordinate; the subordinate appraises himself; others appraise both boss and subordinate.

   To improve productivity and reduce accidents, organizations increasingly are turning toward programs of formal periodic appraisals of individual performance to include responsibilities in accident prevention. Standards of job and safety performance are used as a basis for measurement. An appraisal device is developed and a procedure worked out. Whatever the device and procedure, the outcome is an indication of the needs for training.

Now, assume that from one of the aforementioned recognized means of determining training needs a condition has been identified which calls for safety training. What is the next step? At this point caution is required and a fable is appropriate.

Once upon a time a Sea Horse gathered up his seven pieces of eight and cantered out to find his fortune. Before he had traveled very far he met an Eel, who said,

"Psst. Hey, bud. Where 'ya goin'?"

"I'm going out to find my fortune," replied the Sea Horse, proudly.

> "You're in luck," said the Eel. "For four pieces of eight you can have this speedy flipper, and then you'll be able to get there a lot faster."
>
> "Gee, that's swell," said the Sea Horse, and paid the money and put on the flipper and slithered off at twice the speed. Soon he came upon a Sponge, who said,
>
> "Psst. Hey, bud. Where 'ya going'?"
>
> "I'm going out to find my fortune," replied the Sea Horse.
>
> "You're in luck," said the Sponge. "For a small fee I will let you have this jet-propelled scooter so that you will be able to travel a lot faster."
>
> So the Sea Horse bought the scooter with his remaining money and went zooming through the sea five times as fast. Soon he came upon a Shark, who said,
>
> "Psst. Hey, bud. Where 'ya goin'?"
>
> "I'm going out to find my fortune," replied the Sea Horse.
>
> "You're in luck. If you'll take this short cut," said the Shark, pointing to his open mouth, "you'll save yourself a lot of time."
>
> "Gee, thanks," said the Sea Horse, and zoomed off into the interior of the Shark, there to be devoured.
>
> The moral of this fable is that if you're not sure where you're going, you're liable to end up someplace else -- and not even know it.

Therefore, before preparing instruction and before choosing material, machine, or technique to accomplish the needed training, it is important to be able to state exactly and clearly where you are going or what your training goals and objectives are. First the goals which the trainer intends to reach at the end of the training course must be identified. Then the trainer must select appropriate procedures, content, and methods that are relevant to the objectives and will allow achievement of the goals. In other words, select the techniques for providing the most effective training. Then through various instructional activities cause the trainee to interact with appropriate subject matter in accordance with recognized principles of learning, finally measure or evaluate the trainee's performance relative to achieving the objectives or goals originally selected.

Assuming now that the goals of instruction have been determined, it is now time to give appropriate consideration to the techniques of presenting material to facilitate the greatest degree of learning. What then are some of these techniques?

Consider the training need to be accomplished is that of skills training. Therefore, one of the first requirements which is necessary to facilitate effective training is that of performing a task or job analysis. A task is a logically related set of actions required for the completion of a job objective, or a task is a complete job element. A task analysis, therefore, is breaking down the task to be learned into its basic elements.

Many texts are available which detail the procedures to follow in preparing a task analysis. For additional details on conducting a task analysis the following references are suggested: "Training and Development Handbook" by Craig and Bittel, McGraw-Hill Book Company; "Supervisor's Guide To Human Relations" and "Supervisor's Safety Manual" both by the National Safety Council; and "Preparing Instructional Objectives" by Mager, Fearon Publishers. However, only the basic activities in conducting a task analysis will be discussed herein.

The first activity in the task analysis is listing all the tasks that might be included in the job. It will be useful to list all of these tasks on a simple form in order that information needed for the next activity can be easily recorded. All tasks are not of equal importance in the performance of a job; and, it may not be necessary to teach all of the tasks listed in the analysis. Tasks that are performed frequently may not represent a critical skill. Label each Task 1, 2, or 3 to indicate your judgment of importance. Then you will be able to determine which tasks must be included in the training and which can be eliminated if some selection becomes necessary. Figures 1 and 2 are examples of what a Task Listing Sheet might look like when completed.

The second activity in the task analysis is one of detailing all the steps involved in each task listed on the aforementioned Task Listing Sheet in terms of what the person does when performing each step. If this second activity is not performed it is possible to fall into either of two teaching traps. One is the trap of spending a lot of time teaching something which is difficult to teach, even though not highly important. The other trap is that of forgetting to include in the course something easy to teach but absolutely essential to learn. Figures 3 and 4 will prove helpful in completing the second part of the task analysis.

The third activity in the task analysis, then, is to list each of the steps involved in performing each of the tasks in terms of what is done, rather than in terms of what must be known.

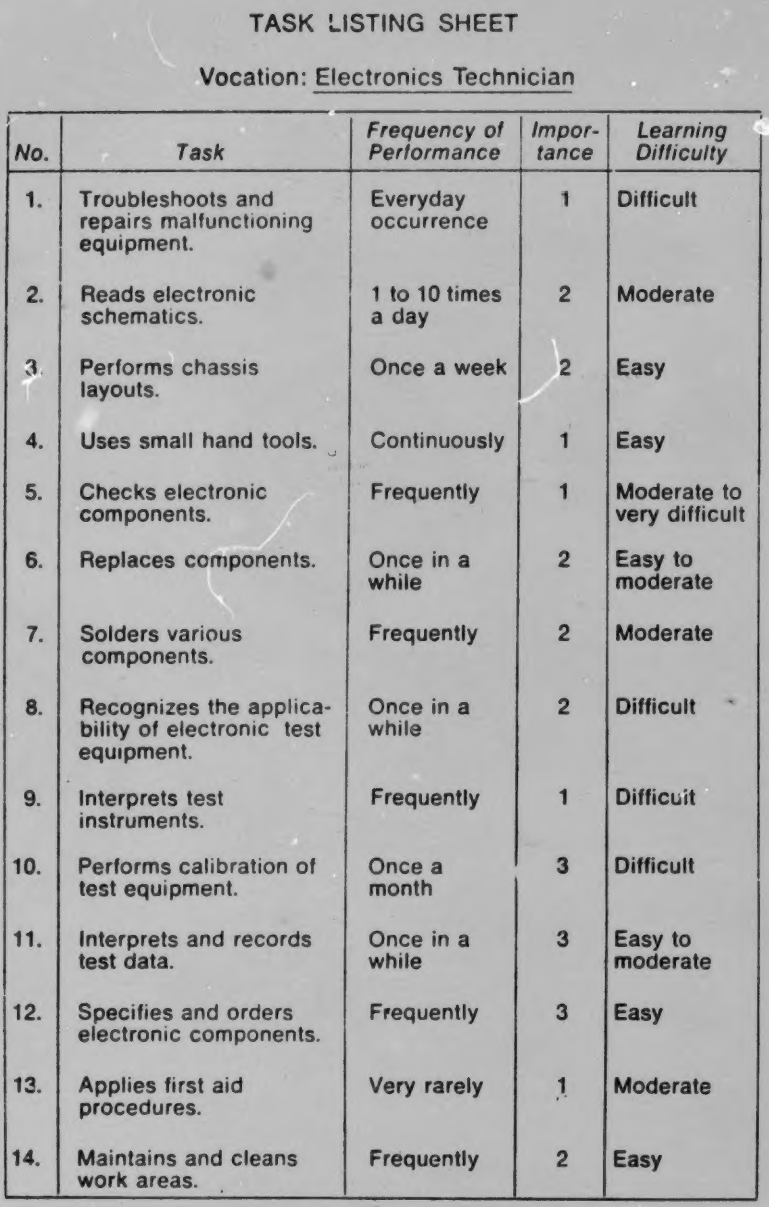
TASK LISTING SHEET

Vocation: ______________________________

No.	Task	Frequency of Performance	Importance	Learning Difficulty

Figure 1

Mager, Robert F., Developing Vocational Instruction,
Fearon Publisher, Belmont, CA. 1967



TASK LISTING SHEET

Vocation: Electronics Technician

No.	*Task*	*Frequency of Performance*	*Impor-tance*	*Learning Difficulty*
1.	Troubleshoots and repairs malfunctioning equipment.	Everyday occurrence	1	Difficult
2.	Reads electronic schematics.	1 to 10 times a day	2	Moderate
3.	Performs chassis layouts.	Once a week	2	Easy
4.	Uses small hand tools.	Continuously	1	Easy
5.	Checks electronic components.	Frequently	1	Moderate to very difficult
6.	Replaces components.	Once in a while	2	Easy to moderate
7.	Solders various components.	Frequently	2	Moderate
8.	Recognizes the applicability of electronic test equipment.	Once in a while	2	Difficult
9.	Interprets test instruments.	Frequently	1	Difficult
10.	Performs calibration of test equipment.	Once a month	3	Difficult
11.	Interprets and records test data.	Once in a while	3	Easy to moderate
12.	Specifies and orders electronic components.	Frequently	3	Easy
13.	Applies first aid procedures.	Very rarely	1	Moderate
14.	Maintains and cleans work areas.	Frequently	2	Easy

Figure 2

Mager, Robert F., Developing Vocational Instruction, Fearon Publisher, Belmont, CA. 1967

TASK DETAILING SHEET

Vocation: ______________________________

Task: ________________________________

No.	*Steps in Performing the Task*	*Type of Performance*	*Learning Difficulty*

Figure 3

Mager, Robert F., Developing Vocational Instruction, Fearon Publisher, Belmont, CA. 1967

TASK DETAILING SHEET

Vocation: X-ray Technician

Task: Take an X-ray of the chest

No.	*Steps in Performing the Task*	*Type of Performance*	*Learning Difficulty*
1.	Patient is asked to prepare for the X-ray by removing excess clothing.	Speech	Easy
2.	Correctly position the patient, giving special instructions.	Manipulation, speech	Moderately difficult
3.	Position and check the proper distance of the tube with respect to the patient.	Discrimination	Moderately difficult
4.	Turn on the X-ray equipment and adjust machine.	Recall	Easy
5.	Insert the X-ray film and identification marker into the proper holder.	Manipulation	Easy
6.	Expose film and release patient from examining room.	Manipulation	Moderately difficult
7.	Process film.	Manipulation	Difficult
8.	Check film for specified positioning or developing errors.	Discrimination	Very difficult
9.	Release patient if film is acceptable to the radiologist.	Recall	✓
10.	Clean examining table and film areas.	Manipulation	✓

Figure 4

Mager, Robert F., Developing Vocational Instruction, Fearon Publisher, Belmont, CA. 1967

After the steps in each task have been listed, it is appropriate to consider two remaining items related to the detailing activity. One is the type of learning or performance involved, the other is the learning difficulty. Information on the former is of critical importance in deciding which teaching technique is appropriate at each step.

While coverage of the task analysis may seem to be going into unnecessary detail, it cannot be over stressed that these steps are essential in making intelligent choices of teaching techniques. Without this detail, one might add hours or days of unnecessary theory to a course for which a task analysis was not prepared, or miss the educational objectives entirely.

There are undoubtedly as many techniques for performing a task analysis as there are people doing it. However, the technique described here, while not detailed, is adequate. If another technique suits your particular needs better, use it. The greatest error that can be made is not to use any task analysis technique at all.

With the task analysis completed and the educational goals and objectives defined it is appropriate to consider instructional techniques. There are many techniques for presenting information and for transmitting skills. However, since all are not equally effective in reaching each instructional goal, it will be useful to discuss the basis on which intelligent choices can be made. A word of caution is in order. Although schools and instructors have been around for centuries, and educational researchers have been at work for decades, there is not yet a science based guide which tells how to make accurate selections of appropriate instructional strategy. Psychological research has, however, provided some insight into this problem. It is hoped that such insights are herein translated into usable guides for the selection of effective instructional procedures and materials.

The instructional procedures and materials toolbox is a full one. It ranges from apprenticeship training, simulators, self-instructional demonstrations, role playing, programmed instruction, lecturing, and field trips through motion pictures, slides, television, filmstrips, transparencies, audio and video tape recordings, to the graphic media of charts, graphs, diagrams, maps, cartoons, and the symbolic media of the written and spoken word.

Each instructional medium or technique has specific characteristics or features. For example: Role playing involves action, doing, and practice. Lecturing is easy to do and is, therefore, convenient for the instructor; but, it forces the trainee to be relatively passive. One feature of the magnetic tape or disk recording is the organized simulation of a series of sounds. If listening discrimination is essential to the learning objective, the audio playback device is likely to have features most relevant to achievement of efficient learning. If on the other hand immediate learner feedback is desired, then programmed instruction may be advantageous.

Projection devices also have distinct features. Slides, transparencies, filmstrips, motion pictures, and television have the common characteristic of presenting a photographic reproduction of reality . . . a mirror image of life, so to speak. Magnification is another common feature, as is color. Editing possibilities are a feature of the slide and the transparency, making possible timely changes and updating of content. The filmstrip, in contrast, features a fixed order of presentation. Adding a tape or disk recording to these picture devices adds a sound-message capability.

With time-lapse and slow- and fast-motion photography, the motion picture can expand and compress the real time scale. Animation, X-ray, and microphotography can reveal processes and concepts invisible to the eye. A documentary record of an important event may be easily reproduced, history may be re-created, and on-site visits made anywhere in the world via the film.

One feature common to several instructional techniques is direct student participation. Supervised on-the-job training, for example, is an instructional procedure that has long been used by vocational-technical educators when development of manipulative skill is the primary goal. Simulators also allow skill development, as do some mock-ups and working models.

There is a large difference, however, between an instructional procedure feature or characteristic and an advantage. A feature or characteristic only become an advantage if it is appropriate or relevant to reaching some educational or training goal. For example: One of the features of a pair of roller skates is that they are relatively inexpensive. But is this feature an advantage? An advantage for what? If the goal is to get across North America by the fastest means available, the feature that roller skates are inexpensive is no advantage at all.

We have in our toolbox a small screwdriver with a blade small enough to fit tiny screws. Is this feature an advantage? It depends entirely on what we are trying to accomplish . . . it depends on our objective. If our immediate goal is to turn a large screw, then the small blade feature is clearly not an advantage. One feature of a small car is that it can be parked more easily than a large station wagon. Is this an advantage? It is if the goal is to do a lot of city driving. But if the goal is to carry as many children to a ballgame as possible in one trip then the characteristic of "smallness" is not an advantage.

Hopefully, the point has been made that the selection of appropriate training techniques begins with determining precisely what performance objectives are desired. With the type of performance identified for each part of the task, it is possible to go about identifying the general class or procedure, or combination of procedures, appropriate for reaching each objective. For example: If one objective is, "given one pair of turbine sounds, the trainee must be able to identify the one most representative of a smooth-running turbine," then some form of audio instruction is appropriate. If one step in learning to perform a task is learning to recognize a properly guarded flywheel and shaft, then some form of visual technique is appropriate; a drawing, slide, photograph, or film might be used. A tape recording or a lecture would be less appropriate in reaching the objective.

There are three guides to follow in selecting appropriate instruction procedures or techniques related to the achievement of each of the performance objectives.

1. Choose the technique that most closely approximates the performance conditions called for by the objective.

2. Choose the technique that causes the student to perform in a manner most closely approximating the performance called for on the job.

3. Choose the technique that will allow the trainee to make the greatest number of relevant responses per unit of instruction time.

After the procedures and materials most relevant to achieving desired performance have been identified, the next step is to choose among them on the basis of availability and administrative criteria. The most appropriate technique isn't always an available technique nor is the most appropriate technique always practical or within the budget.

If it is concluded that slides, filmstrips, motion pictures, CCTV, and photographs would work equally well, select the one that is most available and most likely to be used. If slides, filmstrips, motion pictures, and CCTV are available but normally located somewhere other than the classroom, photographs might be preferable.

The object then, is to select those techniques most relevant to the type of performance involved and make final selections on the basis of availability.

To summarize, then, the selection of instructional techniques involves:

1. Identifying the instructional goals and objectives.

2. Performing a task analysis.

3. Identifying the type of performance desired as a result of instruction.

4. Identifying those instructional techniques most relevant to the desired performance.

5. Selecting those techniques which are most practical from among those appropriate.

MATERIALS AND SERVICES AVAILABLE FROM THE NATIONAL SAFETY COUNCIL

Kenneth F. Licht
Manager, School and College Department
National Safety Council
Chicago, IL

It's been five long years since I've had the opportunity to participate in your annual Campus Safety Conference and it's good to be back! I not only had a great vacation in Santa Barbara at your 17th Annual Conference, I learned a tremendous amount about the important job you're doing to control accidents on college campuses. And I met a great bunch of guys.

I'm especially happy to be with you in Calgary. Your Staff Representative, Jack Green, returned from a planning session for this meeting last year sporting a beautiful 10 gallon hat and literally singing the praises of Calgary's northern hospitality. (Incidentally, Jack asked me to extend his personal greetings and best wishes to all of you, as well as his regrets at not being able to be here. You may know that Jack is on a trip to Europe with his new bride. I'm glad Jack decided to visit Europe when he did cuz it gave me the opportunity to take his place here.)

Another reason why I feel "at home" in Calgary is that my son, who is in the army, spent some time here last year training for an exercise in arctic manuevers in Fort Churchill. He was much impressed with Calgary and I'm looking forward to visiting some of the places he recommended. Before I tell you about some of the materials and services available to you from the Council I'd like to take a moment to tell you something about the Council itself. This may be 'old hat' to some of you, but my field experience has taught me that many people have some misconceptions about the Council and I'd like to clear these up at the outset.

First of all, the National Safety Council is not an agency of the government. We're national - indeed, international - in scope, but we're not Federal. We're a nonprofit (terribly nonprofit, unfortunately), non-governmental, public service membership organization dedicated to accident reduction and control. Our origins go back to 1912, when a small group of men met to deal with burgeoning accident problems in the steel and electrical industries. A year later 2,000 persons met and organized the "National Council for Industrial Safety" which was changed to our present "National Safety Council" in 1914. In 1953 we were granted a Congressional charter "... to arouse and maintain interest in safety and accident prevention, and to encourage the adoption and institution of safety methods by all persons, corporations and other organizations."

So while we're not a government agency, we do have the government's "blessing" to take a national leadership role in accident control. Our disassociation from the government gives us the opportunity to take an unprejudiced view of safety legislation and other governmental activity in the field which we would not be able to do if we were a government agency.

When people learn we're not connected with the government, their next question is usually, "Then where do you get your money?"

The answer is, simply, from sales of materials, services, and memberships. In fact, about 95% of our $12 million budget is derived from these sources. The other 5% comes from miscellaneous sources such as the Trustees Fund, grants, bequests, interest on investments, etc. In short, we're in the business of safety.

Since the first order of business is to stay in business - which means that you need to have at least as much income as outgo - we are sometimes faced with a problem in light of our government charter. While on the one hand we are obligated to serve the public safety interest, that service is limited by what we can afford to do. What happens in practice is that whoever writes to the Council for help - from the schoolboy gathering information for a theme on safety to the safety director of U. S. Steel - gets assistance. But the person who's a member (or whose employer is a member) gets more and better service than the non-member. Not too many years ago the Council was the recipient of a substantial amount of funds designated for support of certain activities. For example, our driver education function was at one time completely underwritten by outside funds. The contributive dollar is no longer easy to come by, and many previously funded programs have had to be absorbed by our regular budget. Consequently we're examining more and more of our programs to see if they really pay-off in terms of accident reduction or if we can at least recoup production costs of such programs.

A more complete word-picture of the Council is available from this publication (What is the National Safety Council?) which briefly describes the variety of programs, research, publications and other activities we conduct.

I've mentioned membership a couple times; let me return to it again. Membership is the lifeblood of the Council. It provides us not only with a steady source of income, it also offers a channel thru which we collect information and transmit it to other members. Thus the Council can be viewed basically as a big information gathering, processing and distribution organization. We currently have a membership of slightly under 16,000 individuals, businesses and industries. I'm happy to say that the number of education institutions in that 16,000 is growing larger every year.

At the risk of sounding like a pitchman, let me urge that you consider a membership in the Council if you don't already have one. I'm not going to suggest a specific membership because we have a variety available and our membership department is best equipped to advise you in this respect. But the advantages of membership are very real, starting with an automatic 20% discount on our materials. The almost endless variety of safety aids in our catalog makes this discount very attractive. But in addition to the discount, members also are provided consultation service through their assigned staff representative. Oftentimes the safety problem you may think is unique to your situation has been handled successfully on some other campus or institution. And our library or other resource may just have that information for you. The National Safety Council library - the largest safety library in the world - provides an invaluable source of information to help solve your safety problems. Assistance in organizing an accident reporting and record-keeping system is also available from our Statistical Department. Members may also use the Green Cross for Safety Emblem in certain prescribed ways, which tells the world - as well as the staff and students on your campus - about your concern for their safety and well-being.

When I was a safety coordinator for a mid-west school system before joining the Council I had an institutional membership in the Council. I thought it was a good deal then; I know it's a good deal now. For more information, write our Membership Department.

I hope you've had an opportunity to examine the materials I've put on display. And I hope you've seen our new film "With Safety for All." If you have, you'll be able to put into perspective some of the items I want to "show and tell about" for the remainder of my presentation. I'm not putting things in any kind of priority listing, but the items I'll mention are, in my estimation, basic to any good safety program.

First, the ACCIDENT PREVENTION MANUAL FOR INDUSTRIAL OPERATIONS. You're not an industrial operation, you say? Well, a quick glance thru this mammoth volume will soon show you how relevant it is to your campus operations. With more than 1,500 pages, over 700 photos, charts, graphs and tables, it provides you with essential information for an effective safety program. This latest edition has new chapters on OSHA and non-employee accident prevention. A cross-reference index helps you find what you need quickly and easily.

ACCIDENT FACTS is the statistical bible of the safety business. Every safety professional needs a copy for quick and easy, authoritative accident statistics. You really can't do without this one. Published annually in July.

The FUNDAMENTALS OF INDUSTRIAL HYGIENE is to your health problems what the Accident Prevention Manual is to your accident problems. It helps you evaluate and control health hazards; provides sources of help and suggests ways to establish a hygiene program for your staff. A glossary of more than 1,000 terms helps you "speak the language" if you're not a health major.

The NATIONAL DIRECTOR OF SAFETY FILMS indexes hundreds of films, filmstrips and slides from a variety of sources, covering virtually all aspects of safety. All the information you need to buy, rent or borrow. When you need a visual aid for your safety program here's where you'll find it.

The Council publishes about eight magazines. the NATIONAL SAFETY NEWS is the official "voice" of NSC, with more than 49,000 copies circulated monthly. Four special emphasis issues are produced each year, any one of which is worth the price of the annual subscription. In March, the focus is Safety Equipment; June, Security and Fire; September, Congress;

and December, Safety Literature. Regular monthly features on OSHA, Washington legislation, Ideas that Work, and the like, keep you current with safety progress. I won't take time to discuss our other magazines, but FAMILY SAFETY is one you should be familiar with. Written in a dramatic, common-sense vein, it really gets the safety message into the home. Off-the-job safety is one of our big problems today, as you know. Getting this publication into the homes of your employees will help keep them accident-free off-the-job so they'll be on-the-job when you need them. Our other magazines deal with traffic safety, farm safety, safety research, and occupational safety. Check our catalog for details.

If you were having safety problems with Abrasive Blasting or Zirconium Powder, where would you look for help? To the NSC INDUSTRIAL DATA SHEETS of course. Approximately 320 specific accident problems are the subjects of these publications, available individually or in complete sets. Also available is a maintenance service which keeps your set up-to-date, and provides a new index and instruction sheet on a quarterly basis. With the complete set on your shelf you're ready for immediate answers to 320 technical safety problems.

I could spend the rest of the day talking about our materials. But it's about time to bring this to a close and give you the opportunity to ask questions. Before I do, I know OSHA is an important concern to many of you, and therefore I'd like to mention a couple items you should know about. First is our newsletter "OSHA Up-To-Date." Issued monthly, it reports latest modifications, interpretations, and proposed changes in occupational safety and health legislation. It keeps you up to date on OSHA.

If you want an inexpensive publication to help analyze your campus compliance with OSHA standards, you need the "OSHA Standards Handbook for Small Business." Don't let the 'small business' orientation fool you; this book gives you clear, concise guidelines for inspecting your own facilities to see how you stack up with OSHA. It's soft cover, crammed with 370 pages of simple-to-use checklists and worksheets. Best, it's only $15.00 - a price you can't afford to pass up. The only catch is that it's presently available to members only and government agencies. But it's worth the cost of membership, in my opinion.

Finally, a word or two about posters. Posters, alone, don't constitute a safety program. But they're an important part of your program. They serve as advertisements, reminders, warnings - and even help mold attitudes. Carefully selected, conspicuously mounted, and changed regularly, they deliver a message in addition to their content: They tell the staff that management cares enough to create a safety poster program. As your Canadian professor puts it, this is a case of the "medium being the message." Our poster directory will not only give you a tremendous variety of posters to choose from but also assistance in how to use them for greatest effectiveness. A good safety poster program is like frosting on the cake.

Well, I hope I've given you a glimmer of what the NSC has to offer in your safety program. If you have questions about specific materials, services or programs, I'd be happy to respond to them now if we have time, or whenever convenient for you.

Thank you for your attention.

'The Use of Audio Visual in Safety Programs'

Paul W. King
Technical Sales Representative
Kodak Canada Limited

Thanks very much Marty. First, I'd like to welcome you to Calgary - I know everybody else has welcomed you, but I hope that you have a very successful conference here and I know that you'll enjoy the wonderful spectacle of the Calgary Stampede. Judging by some of the comments I heard this morning about sore feet, I think that a lot of you have already had a chance to go to the Stampede and have enjoyed walking around there.

Before we get into this discussion on the use of audio visuals in safety training, I wonder if I could just ask 'How many of you, in fact, own any kind of a camera at all? Could anybody who owns any kind of a camera at all put up a hand please? Well, that looks like almost everybody which is just what I expected. Now, if I can narrow it down just a little bit, could anybody who owns what I would call a fairly sophisticated camera, like a Pentax, or a Canon or a Topcon, anybody who owns a camera like that, could all those people raise a hand please? Alright, well again, that's a pretty good percentage of you, and I think that all those people that have that kind of equipment are well on their way to being able to put on an audio visual presentation. For those people who are not camera buffs, I think we're also going to cover some information today which will help you to put on this type of a program. In fact, at the end of this hour, we're going to show you a brief program made by a non-photographer and he really acted in a writing and coordinating function and you could do the same thing; so I think we have a little bit of information for everybody.

I think that as Safety Officers one question which must remain in the forefront of your mind is, 'what can I do to increase safety habits of the staff and students on my particular campus?' One answer to this lies in the use of more effective training. Now, training is really the communication of information and ideas and what you're really hoping for in training is, as Ron told us this morning, a change in peoples' understanding or a change in their ability to undertake some kind of function. Training of any kind is difficult because the person giving the training and those receiving it view the same subject with very different eyes. I think in safety training this is especially difficult because many people have the inate belief that accidents always happen to somebody else. They think it will be somebody else who falls down the stairs, somebody else who gets an electric shock, or somebody else who is trapped by fire. Now, the fact which we can use to overcome this is that 90% of what a person knows they have learned, in fact, is through their eyes.

We live in an extremely visually oriented society. Those people, especially under the age of 30, have grown up with television and all of us now are used to watching television and having information presented to us in a concentrated form. We are used to digesting this and we're used to enjoying it. Another advantage of using audio visual is that it gives us a common frame of reference and both the trainer and the trainee really see the subject the same way. I think one example of this is that I'm sure all of us have pretty much the same idea of what it's like to walk on the moon or what we think the moon's landscape looks like. The reason why we probably all have the same understanding of this is because we've all seen the same movies and the same still photographs, which the astronauts brought back. So, we have a common frame of reference for learning about that particular subject.

In your training you have access to various media. Most campuses have at least one VTR set-up and these are gaining wide acceptance in the training field. If you yourself don't want to use the VTR equipment, you can usually get the media people to operate it for you and help you in that way. Motion picture films have long been used as a training tool, documentaries have been made on motion picture films for a long time; they seem highly acceptable and highly effective. One of the reasons for this is that we all enjoy watching the movies; we equate it with fun, we don't think that a movie is work, that we're learning something or that it's tough. It is a very acceptable way of putting across your safety message or any other form of training. But I think the basic building block of audio visual programming has always been, and will probably remain for some time, the basic slide. Now, the reason for this is slides are extremely cost effective. The cost of transparency film in terms of training programs is minimal; it's easy to update slide programs and almost everywhere you go you'll find a projector that you can project your slides. Really, all you need is a speaker to go with the slides. We'll be talking about that a bit later too - how you can modify that. Putting on slide tape programs is like everything else; there are a few techniques which help to streamline the production, which make it more effective and actually make it easier to produce. Now we're going to watch a multi-media audio visual presentation entitled 'Effective Visual Presentation' and I hope that this will give you some of the 'how to do it' aspects of AV programs.

BUILDING EVACUATION AND RELATED FIRE SAFETY MEASURES

J. L. Pauls
National Research Council of Canada

Campus safety administrators must deal with a variety of buildings and occupancies entailing many of the hazards that are usually found in residential, public assembly, institutional, business, and industrial situations. In addition, they must work within a framework in which lines of authority are complicated by the conflicting goals of administrative control and academic freedom. Furthermore, the persons the safety administrators are trying to protect may appear to be at best apathetic and at worst antagonistic toward personal and property safety and the authority structure within which safety is promoted.

Recognizing the almost certain frustrations of taking an authoritative stance in promoting safety, the campus safety officer may wish to appeal to his campus colleagues' respect for knowledge-based standards of human conduct (at least as an ideal). In addition to explaining established safety practices in terms of their tested validity he might also encourage some colleagues to pursue research studies that might prove useful both in the campus context and elsewhere. The need for such studies, particularly of human-behavioral aspects of fire safety, will become evident in the following description of recent evacuation studies in high-rise office buildings and public-assembly buildings.

HIGH-RISE BUILDING EVACUATION

Until recently it has generally been assumed that in the event of fire in a building the safety of most occupants can be achieved by rapid, total evacuation. The feasibility of this procedure is now increasingly being questioned for high-rise buildings that have large populations and limited means of egress. Buildings may also pose evacuation difficulties because occupants are inadequately instructed and organized, incapable, reluctant, or even hostile. At the same time, with improved design and operating measures, many buildings will require only a very localized, partial evacuation in the event of fire. During the last ten years much research has been done on smoke movement and its control, a fact reflected not only in the technical and popular literature but increasingly in safety regulations.[1-8] Influenced not only by these new safety regulations but also by public concern and corporate conscience, building owners and designers have begun to include, in new high-rise buildings, systems for fire detection and suppression, smoke control, and emergency communication.

Evacuation in its various forms (both in new high-rise buildings or in the vast majority of existing buildings not provided with such new systems) is not well understood. Generally, knowledge about the behavior of building occupants during emergencies is very limited.[9-11] In Canada, since 1969, the movement of people down exit stairs during evacuation drills conducted by the Dominion Fire Commissioner in high-rise office buildings have been documented and the results appear to be useful in predicting what might happen in real fire emergencies. For example, an improved basis for predicting total evacuation time is now available. These results also raise questions about the validity of some traditionally accepted concepts and formulae for exit design.

What follows is a brief description of these results relating to conventional total evacuations and to new forms of selective evacuations. (More detailed reports describing the evacuation study are available.[12, 13]) Although it may not be immediately apparent, many of the evacuation findings apply to a range of campus buildings, not just to high-rise office buildings.

Total Evacuation Procedures

The term "total evacuation" is used to describe the conventional, simultaneous movement of all occupants of a building to the outdoors at ground level by way of stairs. Of the 40 evacuation drills observed in high-rise office buildings in Ottawa, 30 were total evacuations entailing movement of nearly 15,000 people down 60 stairways. Stair use totalled about 75,000 person-storys.

An important factor in total evacuation is the density of evacuees on stairs. It is influenced by each individual's psychological desire for space and interpersonal separation. In the observed drills, most evacuees chose to occupy a space requiring an average of about two stair treads of a typical 44-in. (1.12-m) wide exit stair. (A more detailed discussion of pedestrian densities and movement on stairs is given by Fruin.[14])

Observed descent speeds, which varied according to density, ranged from about eight stories per minute for widely separated individuals to zero for crowd densities equivalent to three evacuees on every two 44-in. (1.12-m) wide stair trends. At the apparently comfortable density of one evacuee on every two trends the descent speed was about four stories per minute.

Flows on stairs, or number of people per minute passing a fixed point, also varied according to density; the highest observed mean flow was about 30 persons per minute per 22 in. (0.56 m) of stair width. This occurred at an average density about 50 per cent greater than the apparently comfortable density just mentioned. In a midwinter total evacuation, with evacuees wearing bulky clothing, mean flows were about 20 persons per minute per 22 in. (0.56 m) of stair width. These flows are much lower than the 45 persons per minute per 22 in. (0.56 m) of stair width frequently stated in the literature and assumed in building codes.

Another noteworthy point is that an increase in the width of stairs, smaller than the 22-in. or 12-in. increments now recognized in building codes, caused a proportional increase in the mean egress flow. With the impending conversion to metric, use of the exit-design formula based on a mean stair flow of four to five persons per minute per 0.10 m (4 in.) of stair width appears more realistic and flexible than the traditional "unit of exit width" formula, described in the NFPA Life Safety Code.[15]

Based on empirically derived density, speed, and flow relations and partially validated by observed total evacuation times, Fig. 1 shows that the time required to complete total evacuation is mainly dependent on actual building population and available stair width. Other factors, not indicated in Fig. 1, include the wearing of bulky clothing by evacuees, evacuee training or experience, and the organizational or management aspects of a total evacuation. Although Fig. 1 is derived from observations in office buildings it does give some indication of the anticipated total evacuation times in other occupancy situations where the evacuation of all occupants begins within a minute or so of an alarm being sounded. (This would probably not be the case in residential high-rise buildings.) As will be described later, the normal egress flows of crowds on stairs in grandstand-type buildings have been found to be similar to those observed in the Ottawa high-rise office evacuations. A similar graph could be used, therefore, to determine acceptable egress facilities for a grandstand.

The predicted times for total evacuations given in Fig. 1 for high-rise office buildings are about 50 per cent longer than the times suggested in previously published predictions.[16] Total evacuations in midwinter, when evacuees wear bulky clothing, could take twice as long as previously predicted.

An improved ability to predict total evacuation times is somewhat academic unless factors affecting the acceptability of the times are considered. For example, when a serious fire occurs, how much time is available before floor areas become smoke logged and for what period of time can stairs be used by crowds of evacuees before smoke becomes psychologically or physiologically unacceptable?[1, 3, 7, 8, 17] Traditionally, 7 to 10 minutes has been acceptable as a workable total evacuation time, but this criterion, like many others, should now be reexamined.

Assessing the adequacy of exit provisions and fire emergency procedures in particular buildings may be done, in part, by carrying out simple evaluations of evacuation exercises and fire protection systems. Such evaluations may lead to improvements in building systems perhaps to the extent that rapid total evacuation is replaced by more selective, less disruptive fire-emergency procedures for building occupants.

Selective Evacuation Procedures

In selective evacuations in high-rise buildings, exit stairs are generally used initially by persons on the fire floor and adjacent floors. In the evacuation studies of high-rise office buildings in Ottawa, about 10 phased evacuation drills were observed. In a typical drill, the hypothetical fire floor was evacuated first, then the adjacent floors, followed by clearance of the remaining floors, starting from the top floors of the building (which could rapidly be made untenable by smoke movement upward as a result of stack action[3, 7]). In these "sequenced" evacuations evacuee densities and flows were usually much lower and stair descent speeds higher than in total evacuations.

Of course, some "costs" are entailed in achieving a selective and controlled evacuation. Paramount among these is the time that is required to monitor the clearing of particular areas of a building, to make decisions about the need for and timing of further evacuations, and to communicate evacuation directions to building occupants. Public address and telephone systems controlled from a central panel must be provided, maintained, tested, and properly operated. Experience of the Dominion Fire Commissioner in Ottawa has shown that neither the provision of equipment nor the training of equipment operators is straightforward and much remains to be learned.[18-20] Finally, the selective evacuation procedures only make sense where there are reasonable expectations that a fire and the products of combustion can be detected and controlled so that only a portion of a building's occupants is endangered. To this list must be added the need for better knowledge of how people will behave in a fire situation, particularly with the selective evacuation procedures requiring that some, perhaps all, of the occupants remain in a building until a fire is extinguished.

HUMAH BEHAVIOR IN FIRE EMERGENCIES

Studies of human behavior during actual fire emergencies reveal that panic is relatively rare. In general, people cope remarkably well not only with fire emergencies but also with a wide variety of disaster situations.[9-11] This is not generally acknowledged in popular accounts of fire incidents, where the term "panic" is often used to describe behavior that may appear to be excited but which, in the emergency context, is quite reasonable. (In technical literature, the term "panic" refers to non-rational, non-adaptive, and possibly non-social behavior.)

A recent British study (at present being extended in the U.S.A.) is noteworthy. Questionnaires were used to help describe the behavior of over 2,000 people involved in nearly 1,000 fires attended by fire brigades. The various actions taken by these people were cross-tabulated with personal, building, and fire variables. Evacuation of the buildings and movement through smoke were two important areas of interest, and many findings of a descriptive nature are listed in the report. The report states, "In general terms the majority of people appeared to have behaved in what might be considered an appropriate fashion, although some 5 per cent of the people did something which was judged to 'increase the risk'. There was little evidence of true 'panic'."[9]

RELATED STUDIES OF NORMAL BUILDING USE

One additional recent aspect of Canadian evacuation studies is relevant to the task of campus safety officers. This deals with the normal egress movement of crowds of people from buildings having assembly occupancies. Observations of such movement in theaters, arenas, and grandstands were begun in 1973. In mid-1974, extensive observations were conducted in the new triple-tier 17,000-seat Calgary Stampede Grandstand.[21] These provided data concerning flow capacities of the many stairs (about 200 flights) used for egress from the building, and useful information on how crowds (composed of a wide range of ages and abilities) cope with unfamiliar means of egress. The densities, speeds, and flows on the Calgary Grandstand stairs were found to be comparable to those measured in high-rise office building evacuation drills.

Campus safety officers, dealing as they do with buildings with assembly occupancies (e.g., lecture theaters, arenas, stadia) could perform a valuable service by initiating small-scale studies of normal crowd flow which frequently occurs in such buildings. The results would undoubtedly indicate some of the difficulties to be overcome (in terms of building design or management) in an emergency evacuation situation and might also be of wider significance in the general design of similar facilities elsewhere.

CONCLUDING REMARKS

This paper has touched on a few of the safety matters of concern particularly to campus safety administrators. Two further concerns, fire drills and fire safety education, could have been discussed at some length. As suggested in the introductory comments, these may be viewed antagonistically or apathetically by many of the people usually found on campuses. There are no easy solutions here.

Fire drills may be useful in certain buildings and in certain occupancy contexts; however, they can also do more harm than good. Periodic total evacuation drills are of value in a building which contains extreme fire hazards, which is not adequately compartmented, or which, for some other reason, does not offer protection against rapid fire and smoke spread. An important consideration in such drills is that building occupants appreciate the hazards and the need, therefore, to be capable of rapid total evacuation. In high-rise residential buildings, having a high degree of compartmentation limiting fire and smoke spread, the training of occupants to evacuate rapidly is generally not warranted. Other campus occupancies may be better served by selective evacuation procedures requiring more specialized training on the part of a small number of staff personnel.

Perhaps more important than conditioning people to evacuate the building is the task of promoting a broader appreciation what can be done to prevent fires and how to deal with them should they occur. Campus safety and the long-term awareness of those on campus as students will both be improved by making safety an intrinsic aspect of normal occupancy activities rather than something viewed solely as authoritarian imposition. A constructively critical or research attitude toward safety practices may appeal to many on campuses and, equally important, it may help provide information which is needed to supplement or even supplant existing tradition-based approaches to safety. The need for knowledge-based approaches to safety in general[22] should be a concern of safety administrators.

One of the suggestions, arising from studies of evacuation of buildings described briefly in this paper was that conventional wisdom (and even some of the presumably-technical literature) may be in error. It is hoped, however, that these studies have, at the same time, indicated alternate approaches to designing and operating some of the fire safety facilities in buildings to achieve equivalent or perhaps better than equivalent levels of safety.

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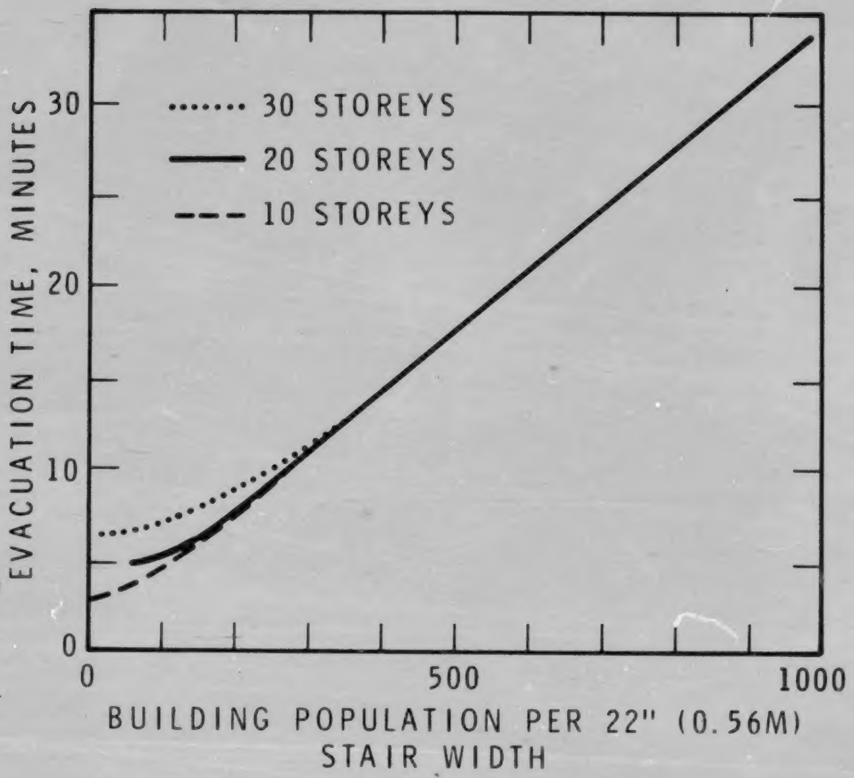

Figure 1 Predicted total evacuation time for high-rise office buildings using exit stairways.

PEOPLE INVOLVEMENT IN HIGH-RISE BUILDING EMERGENCIES ON UNIVERSITY CAMPUSES

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The fire fighting problems of a high-rise building are similar to those of a large ship in which rescue and fire fighting procedures must be carried out internally as most of the floors are out of reach of effective external operations. Consequently there is a similar large potential for disaster.

Traditionally, fire safety in buildings requires that all occupants evacuate the building immediately after the sounding of the fire alarm. This allows the fire department to begin fire fighting and rescue operations in an evacuated or nearly evacuated building. This immediate evacuation concept was and still is the basis of most current building code requirements. It provides for the evacuation of the building occupants through a combination of enclosed escape stairwells and a fire separation at each floor. These requirements have proven acceptable for all buildings except those of excessive height.

Paralleling the development of the modern high-rise building are new innovations in fire detection and fire control equipment: flame detectors, heat detector thermostats, rate-of-rise heat detectors, combination heat detectors, smoke detectors and products of combustion detectors, all in addition to more sophisticated fire alarm circuitry. All have been installed in high buildings to a greater or lesser degree. But regretfully, many, although accredited by nationally recognized fire test laboratories, are far from reliable and require highly skilled installations and maintenance. All too many installations are doubtful. The results are too many false alarms - estimated to run to 90% of those received -- and system failures.

The frequency of false alarms demonstrated several shortcomings in applying existing fire emergency procedures to high-rise buildings and created an urgent need for their review. On May 24, 1968, an unannounced full-scale fire emergency exercise was held in a 22 story office building in downtown Ottawa to assess the feasibility of evacuating such a building on an immediate basis. Chaos and a near panic situation occurred. After half an hour only some 8 floors had been cleared and all stairways were blocked. But this experiment proved conclusively to our minds that it is impossible to effect total immediate evacuation of a high-rise office building within a safe period of time.

This point established, the Dominion Fire Commissioner constituted a special task group within the Government of Canada to evaluate the total fire safety problem of high-rise office buildings. The study embraced a review of U.S. practices, including an on-the-spot survey of several buildings in New York City. It soon became evident that post World War II high-rise buildings pose a new and different set of problems to those of earlier structures and that a fundamentally new approach was needed.

Recommendations were published in a special report "Fire Safety in High-Rise Office Buildings" published in April, 1969. All the recommendations have now subsequently been substantially incorporated into the National Building Code of Canada. Operating procedures have been recommended for inclusion in the National Fire Code of Canada now under revision.

The behavior of fires in high-rise buildings is being studied on a continuing basis and to date the recommendations of the report have been totally substantiated.

CURRENT EVACUATION PROCEDURES IN HIGH-RISE BUILDINGS

Current emergency procedures used in most Government of Canada high-rise buildings now use the principle of phased evacuation. It maximizes the use of the stairways but avoids overcrowding and panic situations.

For offices and related occupancies in which the floor areas are largely non-compartmented, the fire floor is first evacuated followed by the floors immediately above and below. The remainder of the building is then progressively evacuated starting at the top floor. No persons are restrained if they wish to leave.

For compartmented buildings, such as apartment buildings, university campus dormitories, phased evacuation is such that the occupant of the fire suite is first evacuated followed by progressive evacuation of the fire floor, the floor above and floor below, then the top floor downwards, the degree of evacuation being dependent upon the assessment of the fire situation by the responding fire department.

Phased evacuation procedures are to be in effect when the building is in full operation only with a full occupant load, otherwise immediate evacuation is required. Hence, in a flexible working hour situation in an office building, phased evacuation procedures will only be in effect during "core" hours. In an apartment building, phased evacuation procedures will always be in effect. In a partly occupied building, immediate evacuation procedures will be in effect.

INTEGRATED FIRE ALARM AND VOICE COMMUNICATION SYSTEM

To effect these phased evacuation procedures, two related components are essential:

- An effective integrated fire alarm and voice communication system; and
- Availability of competent personnel to operate the system in accordance with a predetermined fire safety plan.

A breakdown in either of these components could have serious consequences in a fire emergency situation and it is essential that they both be maintained.

The essential features of an integrated fire alarm and voice communication system are a central control console provided with:

- Input from the fire alarm system with automatic output to building and fire department alarms, and controlling relays for elevators and air handling systems.

- A telephone system with communication to all floors.

- A microphone connected to a loudspeaker system throughout the building.

Many such systems have been tested out in Department of Public Works controlled high-rise buildings under both simulated and actual emergency conditions and the following performance requirements formulated in a published Standard.

CENTRAL CONTROL

INTEGRATED FIRE ALARM AND VOICE COMMUNICATION SYSTEMS SHALL BE CONTROLLED FROM A CENTRAL CONTROL FACILITY LOCATED -

- ON THE STREET ENTRANCE FLOOR OF THE BUILDING TO WHICH THE FIRE DEPARTMENT WOULD NORMALLY RESPOND; AND

- WITHIN A SOUND RESISTANT ENCLOSURE.

Early installations had this central control installed in the open entrance lobby area and the noise of people evacuating almost completely impaired its operation. The enclosure is to be of noncombustible construction and of adequate size to accommodate both equipment and personnel (at least two persons) and permit maintenance of the equipment. It is also advantageous but not essential if the enclosure can provide for vision of the main lobby area. It is essential that the central control is in the form of a desk console to permit the operator to keep a record of the evacuation status of the building.

CENTRAL CONTROL SHALL BE PROVIDED WITH -

- MEANS TO INDICATE VISUALLY AND AUDIBLY THE FLOOR FROM WHICH THE ALARM SIGNAL WAS INITIATED.

This refers to the evacuation alarm system in the building.

- MEANS TO INDICATE VISUALLY AND AUDIBLY ALL REQUIRED ALARMS FROM SPRINKLER SYSTEMS, AUTOMATIC FIRE PROTECTION SYSTEMS, AND AUTOMATIC FIRE DETECTION SYSTEMS.

- A SWITCH TO SILENCE THE AUDIBLE SIGNAL AT CENTRAL CONTROL.

This silencing switch is for the bell or buzzer at central control only.

- A SWITCH TO SILENCE BELLS THROUGHOUT THE BUILDING, BUT ONLY AFTER A MINIMUM OPERATING PERIOD OF ONE MINUTE.

The minute delay has a two-fold purpose: it positively indicates to building occupants that there is an alarm, and gives time for the manning of central control. The silencing switch is to be indicated by a flashing signal when it is in operation.

. A MANUAL FIRE ALARM STATION TO ACTIVATE BELLS THROUGHOUT THE BUILDING.

This switch is to take the form of a manual fire alarm box.

. MEANS TO CONTROL LOUDSPEAKERS AND TELEPHONE HANDSETS.

. MEANS TO RECORD ALL VOICE TRAFFIC AND ALARM SIGNALS.

. MEANS TO TRANSMIT AUTOMATICALLY ANY ALARM SIGNAL TO THE FIRE DEPARTMENT.

. MEANS TO SHUT DOWN BUILDING AIR HANDLING SYSTEMS.

If the building is equipped with a smoke movement control system, then the control switches for such a system are to be on the console.

. MEANS TO CAUSE THE TOP VENT TO OPEN WHEN THERE IS AN APPROVED SMOKE SHAFT.

Floor vents to any smoke shaft are required to be controlled from the floor below.

. MEANS TO CAUSE ALL REQUIRED FIRE DOORS TO CLOSE AUTOMATICALLY.

This refers only to those fire doors normally held open.

. MEANS TO RETURN ELEVATOR CARS TO THE MAIN FLOOR.

The main floor is considered that one to which the fire department will respond. In the case of double-decker cars, the upper car shall be the one considered.

. MEANS TO STOP ALL ESCALATORS.

This includes the activation of self-covering devices.

. MEANS TO SHUT OFF BACKGROUND MUSIC SYSTEMS.

FIRE ALARM

ANY MANUAL FIRE ALARM STATION OR HEAT DETECTOR SHALL -

. CAUSE "BELLS" TO SOUND THROUGHOUT THE BUILDING

During the Task Group study, it was found that many high-rise buildings in U.S. cities did not have any evacuation fire alarm system. Others only had single floor alarms. Based upon theoretical considerations the fire floor only evacuation alarm system seemed most appropriate and so it was one of the Department of Public Works Task Group recommendations. Actual experience proved otherwise. Quite frequently the initial alarm - either on a manual or automatic basis - does not originate from the fire floor. This is one of the principal objections against the use of a fully automated system with pre-recorded taped messages. Similarly, without a general fire alarm, it proved difficult to alert building emergency personnel. And so all bells were required to be sounded. It is permissible, subject to local approval, to transmit the bell sound over loudspeakers.

. INDICATE THE FLOOR FROM WHICH THE ALARM SIGNAL WAS INITIATED BY MEANS OF A VISUAL AND AUDIBLE SIGNAL AT THE CENTRAL CONTROL.

A zone alarm proved only to complicate emergency procedures and so it was required that only floors be annunciated.

. SHUT DOWN BUILDING AIR HANDLING SYSTEMS UNTIL MANUALLY RESTARTED.

An exception to this are systems specially designed for smoke movement control.

. TRANSMIT THE ALARM SIGNAL TO THE MUNICIPAL FIRE DEPARTMENT.

This avoids the serious type of delay highlighted in the Sao Paulo disasters.

. RETURN ALL ELEVATOR CARS DIRECTLY TO THE MAIN FLOOR.

Again, this is the floor to which the fire department will respond. The fire record is full of cases where people have been trapped in elevators and asphyxiated.

. STOP ALL ESCALATORS.

. INITIATE OPERATION OF TAPE RECORDING EQUIPMENT

This is more completely described under VOICE COMMUNICATION.

. CAUSE ALL FIRE DOORS TO CLOSE AUTOMATICALLY.

This refers to all doors normally held open by electro-magnetic devices.

. SHUT OFF BACKGROUND MUSIC SYSTEMS.

VOICE COMMUNICATION

VOICE COMMUNICATION SHALL BE PROVIDED BETWEEN CENTRAL CONTROL AND FLOOR AREAS BY MEANS OF -

. LOUDSPEAKERS CONNECTED TO A MICROPHONE AT CENTRAL CONTROL.

- EMERGENCY TELEPHONE HANDSETS IN ALL FLOOR AREAS CONNECTED TO ONE AT CENTRAL CONTROL.

Some microphones at central control have an integrated switch capable of silencing all bells when it is depressed, but again only after the bells have operated for a minimum period of one minute. Early designs only provided this switch as the shut-off for the bells. Experience proved that the bells would sound intermittently as the operator slackened his pressure on the switch. Present practice eliminates the requirement for this switch as it is on the low voltage electronic part of the circuitry and if required is to silence an electrical circuit. Many failures have been experienced in such installations.

- LOUDSPEAKERS SHALL PROVIDE EFFECTIVE VOICE COMMUNICATION TO THE FOLLOWING AREAS:

The simple requirement is for loudspeakers to provide voice communication to all areas of the building, but experience has proven that never-ending floor layout changes seriously impair the effectiveness of such a system and so effective communication is concentrated on certain areas where on sounding of the fire alarm bells the building occupants are expected to congregate.

- ALL BASEMENT FLOOR AREAS.

This includes storage and garage areas.

- ALL EXIT STAIRWAYS.

Early systems missed this important area and the omission resulted in confusion during building evacuations mainly caused by the fire department advising that the building emergency was over but unable to advise building occupants in the stairways of this fact.

- ALL STAIR AND ELEVATOR LOBBIES.

Speakers in these are to be on the floor circuits.

- MAIN ENTRANCE LOBBY.

These are required so that people will not congregate in this area.

- ALL CORRIDORS.

These are corridors providing access to exits and is the area where occupants are expected to congregate in office buildings when the alarm bells sound. In the case of open office floor areas, aisle space adjacent to each exit stairway is to be provided with voice communication to an effective area sufficient to accommodate ALL persons on the floor on the basis of 5 sq. ft. per person but not less than 5 per cent of the total floor area.

- ALL SERVICE FLOOR AREAS WHERE PEOPLE MAY BE WORKING.

These include boiler rooms and fan rooms.

- ALL APPROVED AREAS OF REFUGE WHEN PROVIDED.

An early concept in high-rise fire safety was the provision of such areas, but their provision did not prove economically feasible.

- ALL INSTITUTIONAL FLOOR AREAS.

ALL ASSEMBLY AREAS SUCH AS THEATRES AND CONFERENCE ROOMS ARE INCLUDED.

- ALL RESIDENTIAL FLOOR AREAS.

This includes apartment suites.

- ALL MERCANTILE FLOOR AREAS.

This includes boutiques in office complexes.

- LOUDSPEAKERS SHALL BE GROUPED BY FLOOR AREA AND EXIT STAIRWAYS, AND COLLECTIVELY FROM THE CENTRAL ALARM AND CONTROL FACILITY.

This is to simplify emergency operation procedures. The usual practice is to use the "All Call" button but in certain instances messages are required to be given to a particular floor or the stairways only.

TELEPHONE SYSTEM

- A TELEPHONE HANDSET AT CENTRAL CONTROL SHALL PROVIDE COMMUNICATION WITH HANDSETS ON ALL FLOOR AREAS OF THE BUILDING.

One telephone handset or telephone jack is required within 20 feet of clear and unobstructed travel distance from each exit stairway and as remote as possible from the nearest bell to minimize sound interference. The telephones on any one floor are to be grouped.

- UNDER NORMAL OPERATING CONDITIONS, THE TELEPHONE SYSTEM SHALL OPERATE ON A PARTY-LINE BASIS AND ANNUNCIATE THE FLOOR AREA WHERE THE HANDSET IS LOCATED.

This is the usual operation procedure for fire emergency situations.

- UNDER UNUSUAL EMERGENCY OPERATING CONDITIONS, THE TELEPHONE SYSTEM SHALL BE OPERABLE ON A PRIVATE-LINE BASIS WITH THE HANDSET AT CENTRAL CONTROL.

This provides for emergency incidents other than fire, such as bomb threats.

- TELEPHONE HANDSETS SHALL BE PROVIDED WITH "PRESS-TO-TALK" BARS.

Experience has proven that the bars are more reliable than buttons. The arrangement is such that if the handset is raised from its bracket and the bar not depressed, messages may be received from, but not transmitted to, the central control.

- SUBJECT TO SPECIFIC APPROVAL, TELEPHONE JACKS MAY BE PROVIDED IN LIEU OF TELEPHONE HANDSETS. IN SUCH CASES, AT LEAST TWO PORTABLE TELEPHONES SHALL BE LOCATED AT CENTRAL CONTROL.

This is where vandalism may occur, such as in apartment corridors and basement garages.

- ALL CIRCUITS TO LOUDSPEAKERS AND EMERGENCY TELEPHONE HANDSETS SHALL BE ELECTRICALLY SUPERVISED.

An open or ground fault on any circuit shall be indicated.

EMERGENCY POWER

EMERGENCY POWER SHALL BE OF SUFFICIENT CAPACITY TO OPERATE INTEGRATED FIRE ALARM AND VOICE COMMUNICATION SYSTEMS FOR A PERIOD OF NOT LESS THAN 2 HOURS, EXCEPT THAT THE "BELLS" ARE ONLY REQUIRED TO OPERATE FOR 20 MINUTES ON EMERGENCY POWER.

AUTHORIZED USERS OF THE SYSTEM

THE USE OF INTEGRATED FIRE ALARM AND VOICE COMMUNICATION SYSTEMS SHALL NORMALLY BE RESTRICTED TO FIRE EMERGENCY PURPOSES. VOICE COMMUNICATION SYSTEMS SHALL ONLY BE USED BY -

- PERSONNEL WHO HAVE SUCCESSFULLY COMPLETED AN ACCREDITED TRAINING COURSE: AND
- FIRE DEPARTMENT PERSONNEL.

TESTING

A WEEKLY TEST OF THE VOICE COMMUNICATION SYSTEM SHALL BE CARRIED OUT DURING NORMAL WORKING HOURS AT A REGULAR SCHEDULED TIME. THIS TEST SHALL INCLUDE THE FOLLOWING OPERATIONS:

- A MESSAGE SHALL BE TRANSMITTED OVER ALL THE LOUDSPEAKERS USING THE MICROPHONE AT THE CENTRAL CONTROL.
- A MESSAGE SHALL BE RELAYED FROM ONE TELEPHONE HANDSET ON EACH FLOOR CONFIRMING THAT THE LOUDSPEAKERS IN THE FLOOR OPERATED SATISFACTORILY.
- TELEPHONE MESSAGES SHALL BE ACKNOWLEDGED AT CENTRAL CONTROL.

This test is to ensure that all speakers and telephones are operative, and gives the voice communication operator practice. The procedure should take approximately one minute per floor.

A TEST ONCE EVERY THREE MONTHS SHALL BE MADE OF THE INTEGRATED FIRE ALARM AND VOICE COMMUNICATION SYSTEM AND ALL EMERGENCY SYSTEMS ACTUATED FROM THE

CENTRAL ALARM AND CONTROL FACILITY UNDER SIMULATED FIRE EMERGENCY CONDITIONS. ALL TESTS SHALL BE MADE AT A REGULAR SCHEDULED TIME AND THE FOLLOWING CHECKED:

- . ONE MANUAL FIRE ALARM STATION ON A ROTATIVE BASIS;
- . ALL "BELLS";
- . ALL VISUAL AND AUDIBLE INDICATING DEVICES AT CENTRAL CONTROL;
- . ALL CONTROLS INCLUDING ALARM SILENCING AND TRANSFERRING DEVICES;
- . THE TRANSMISSION OF THE ALARM TO THE MUNICIPAL FIRE DEPARTMENT;
- . ALL LOUDSPEAKERS BY ACTUATING THEM SELECTIVELY AND COLLECTIVELY;
- . TELEPHONE HANDSETS BY TRANSMITTING CALLS ON BOTH A PARTY- AND PRIVATE-LINE BASIS;
- . BUILDING SERVICE FACILITIES INCLUDING, WHERE APPLICABLE, THE AUTOMATIC SHUT DOWN OR EMERGENCY OPERATION OF BUILDING AIR HANDLING SYSTEMS, THE OPERATION OF FIRE DOORS, THE RETURN OF ELEVATOR CARS, THE STOPPING OF ESCALATORS, AND THE SILENCING OF BACKGROUND MUSIC SYSTEMS;

Due to practical difficulties in testing air handling systems usually involving the resetting of many fire dampers, permission is given for annual testing of this interlock.

- . THE RECORDING MEANS SUBMITTING THE USED CASSETTE.

The purpose is to test all high-rise building emergency systems to ensure they are operative. It is also to be carried out in conjunction with a phased evacuation drill procedure involving at least 3 floors of the building and so arranged that all building occupants are involved in a drill once a year. This latter procedure tests the systems under simulated fire conditions, acquaints and reassures building occupants of building emergency procedures, and gives practice and subsequent confidence to the Building Fire Emergency Organization.

BUILDING FIRE EMERGENCY PROCEDURES

Many buildings today are being equipped with fire alarm and voice communication systems not meeting the performance requirements desired. Many buildings are being equipped with systems that are not being maintained. But what is more serious, most buildings are without any capability of operating the system either by the building occupants or by the local fire department.

At one time, it was considered that the basic evacuation instructions could be given automatically using prerecorded self-winding taped messages programmed to be activated by the fire alarm system. Such a system has been installed in a new GSA building in Seattle, Washington. Many instances have occurred and are occurring where the original alarm - either manual or automatic - does not originate from the fire floor and in such circumstances an automated system could prove hazardous to the building occupants.

Persons accredited to operate effectively an integrated firm alarm and control system must possess aptitude, skill, training and experience. For Government of Canada buildings, we select and train volunteer operators in a formalized 3-day orientation course using a central control simulator into which we feed all manner of problem situations. Operators who graduate from the course, and there is a high failure rate from those originally selected, are accredited and are then given further training on the Central Control Console in the building where they work. Further experience is acquired and maintained by carrying out the weekly and three-monthly test procedures. They are in responsible charge of all emergency situations in the building until the arrival of the fire department.

It is considered that there should be 8 such trained operators available in every high-rise office building so as to provide manning at all times during the core working hours of the building.

The question of full-time paid staff to carry out this function in all buildings has been temporarily dismissed as it would take 3 full-time staff per building to man the Central Control Console. However, in some of the larger complexes involving many towers with a central control facility that also incorporates building security and/or building environment control system, the console is manned by full-time professionals.

One of the essential requirements for the operation of Central Control is that the volunteer emergency personnel must be able to reach the console within one minute of the commencement of the sounding of the bells. They must thus all work on the bottom 5 floors of the building.

As part of the high-rise building fire safety plan, it is also required that at least 2 persons on each floor are assigned to man and operate the emergency telephones. In addition to performing this task, these Floor Fire Emergency Officers educate and train every floor occupant on the evacuation procedures, operation and use of portable fire extinguishers and standpipe hose.

For compartmented high-rise buildings, such as apartments and dormitories, it is considered that the operation of the Central Control Console should be left with the responding fire department, all in accordance with a predetermined fire safety plan using phased evacuation procedures. However, the responsible building authorities should seriously consider the advantages of organizing the building occupants to perform in accordance with the predetermined fire safety plan.

CONCLUSION

In summary, an integrated fire alarm and voice communication system operated by an effective trained fire emergency organization on the basis of a sound fire safety plan for phased evacuation is perhaps the most essential feature of high-rise building fire safety.

Although perhaps the system is complex, the principles are simple. High-rise buildings by definition are required to be largely self-sufficient in a fire emergency situation. They represent an ever-present challenge which must be met if we are to avoid replicas of the Sao Paulo disasters.

HIGH RISE BUILDINGS

Chief R. Binnion
Fire Prevention Bureau
City of Calgary

The buildings on campus grounds require fire pre-planning the same as any other large building. The success in any major tactical operation of firefighting depends in a large measure, upon pre-fire planning.

The pre-planning starts with checking plans prior to commencement of any construction. In the examination of these plans, special consideration must be given to the size and location of water mains and the location and positioning of fire hydrants. It is most important to estimate the potential volume of fire and the number of streams that will be necessary to cope with a major fire. Access for fire equipment is important; the width, location and design of roadways capable of carrying fire trucks at all times.

After construction has begun, a visit to the site at least weekly to insure:

1. Suitable access for fire apparatus is maintained.
2. Standpipe risers go up with the buildings.
3. That fire safe practices are being enforced.

When buildings have been completed, a regular fire inspection program should be developed. These inspections should be performed for the purpose of obtaining information for pre-fire planning which is the development of appropriate procedures for handling fires and emergencies.

- Checking buildings for situations which create fire hazards affecting life safety.
- Consultation with building supervisors on matters affecting fire safety.
- Regulating the storage of dangerous materials and all other matters that could lead to a fire condition.

Fires in buildings, generally, must be extinguished manually. This can often be difficult and dangerous and the success or failure of this could depend on the building equipment. The inspector should be thorough on the inspection of fire extinguishing equipment, making sure it is in a workable condition.

When pre-fire planning, serious consideration must be given to salvage operations. To a great extent, the amount of damage in many fires will depend upon how well salvage operations are carried out, not only during the fire but also after the fire has been extinguished. The restoration of important services following a fire must also be considered. All salvage operations require both planning and manpower. Often losses to contents far exceed the amount of structural damage.

If evacuation is necessary, the officer in charge will determine whether or not it should be a partial or a complete evacuation. Danger from the actual fire is unlikely except for the occupants of the immediate area which is involved, however smoke and products of combustion can be very serious in the endangered areas. Regardless of whether it is a partial or complete evacuation, it must be accomplished in a safe manner and without panic. It is very important to have fire personnel stationed on every floor to be evacuated. Have the occupants use stairways. Give special considerations to the handicapped. If elevators are to be used for these people, then it must be operated by authorized persons. Occupants should be directed downstairs not obstructed by hose and other fire equipment.

Direct the occupants to safe areas such as other buildings, garage areas, etc. Have police assistance to insure that no one reenters the building until authorized to do so.

Fire pre-planning must be kept under constant review, any change in occupancy or in the building must be taken into consideration. Pre-fire planning must be flexible and changes made with a minimum of effort.

It is generally accepted that any plan is considered better than no plan, however, no matter how thorough the subject has been studied and how many times the plan has been reviewed, when fire strikes it is unpredictable; no one can tell how far the fire will extend, how much damage it will cause or how many lives will be lost.

New Building Codes have special provisions for high-rise buildings. Under controlled conditions, these facilities appear to be the answer to the fire problem, however, every fire is different and people react differently. In one set of circumstances, people will behave very rationally and in other circumstances, their behavior will be totally different and unpredictable.

Fire Departments throughout the continent realize that the only acceptable means of protecting high-rise buildings is to have them completely sprinklered. If any of you have any say in building fire protection, do your people and Fire Departments a favor and get them sprinklered.

THE ROLE OF THE INDUSTRIAL HYGIENIST IN ENVIRONMENTAL HEALTH AND SAFETY

William L. Pendgraft
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The Occupational Safety and Health Act of 1970 has given rebirth to a profession known as Industrial Hygiene. OSHA includes provisions for occupational health which are expected, in time, to overshadow the occupational safety aspects of the Act. To date, safety has been the major consideration forced upon industry by OSHA. The impact of industrial hygiene aspects are only beginning to be felt.

In the late sixties, I, as a science educator, became quite involved with the public's keen interest in and awareness of the environment.

In the early seventies, I was asked if I would like to become an industrial hygienist with a national insurance company. My immediate response was--what is an industrial hygienist? Of course, I had taught biology for a number of years and I knew what hygiene was--and industry--oh, yes! It must be inspecting toilet areas! No, my friends, it is much more exciting and much more involved than that.

As the manager of an Environmental Health Division of an insurance company loss control department, trying to develop an industrial hygiene program, I found that our educational institutions were doing a very poor job of providing true industrial hygiene graduates. Therefore, I attempted to train safety engineers and science grads to become industrial hygienists. In making this attempt, I needed an introduction to Industrial Hygiene and developed the following slide-tape presentation which I would like to show at this time. I have altered the presentation somewhat to relate more to the educational environment. This is an attempt to compare the laymen's environmental awareness with his overlooked day-by-day environment.

(30 minute slide-type presentation, "Storm Arising")

As we have just seen, Industrial Hygiene is the science of protecting man's health through the control of the work environment. Man and his environment are indivisible.

Historically, there has always been very little concern for protecting the health of the worker. The U. S. Public Health Service has been a world leader in evaluating diseases of the working man and development of controls, as well as fostering an interest in occupational diseases by various state agencies, universities, management and unions.

The purpose of a campus industrial hygiene program is to ascertain, evaluate and control those environmental factors and stresses--physical, chemical, and biological--which may cause sickness or impair the health and/or produce significant discomfort and reduction in efficiency of the students, faculty and staff. The title seems to presuppose that this need exists on every campus. It does!

Some of you, certainly many of you administrators, may question this supposition, particularly since there are always associated financial costs and expenses in the establishment of an industrial hygiene program. Let's take a look at some areas of concern on our various campuses in which industrial hygiene becomes involved.

Any area of any college campus is a source of potential hazards of varying kinds. For instance, the use of machinery on campus raises the possibility of several dangerous situations. The noise levels of tractors used in ground maintenance and snow removal operations may be damaging to the ears of the operator. In areas where forklifts, floor cleaners or other internal combustion engines are used in enclosed areas, carbon monoxide poisoning is a definite hazard. If the campus has a parking ramp which is partially or entirely enclosed, there may be ventilation problems caused by inadequate removal of car exhausts.

In the art department, metal sculpture work involves welding with oxy-acetylene, electric arc or gas shielded arc torches.

Silver solder used in jewelry making may produce cadmium poisoning, and silk screening involves the use of solvents which require good ventilation for proper safety. Home economics departments may be using expanded polyurethane, which may cause diisocyanate hazards.

The science departments of any college contain many possible hazards. In chemistry labs, uncontrolled or poorly exhausted use of hydrogen sulfide, benzol, silenium, HF, etc., can result in numerous health hazards, and some can be deadly.

Poor ventilation systems in biology or chemistry labs allow normally non-toxic gases and dusts to accumulate, causing breathing difficulties and possible lung damage. Dark rooms many times have inadequate ventilation systems for the use of developers and fixatives to which a person can become sensitized.

Departments in supporting services are also vulnerable to potential hazards. Microwave ovens in food service or vending machine areas may be leaking radiation above permissible levels. Spray painting areas and degreasing tanks in the maintenance shop may be (and probably are) leaking toxic vapors. Exposure to chlorine or bromine is possible in water treatment and swimming pool areas. The noise levels in the heat and power plants are likely to be above damaging levels, a hazard that applies equally to carpenter and metal working shops.

A quick hop, skip and jump survey like this is, of course, not complete, but it can be used as a beginning to make a campus-wide survey of necessary study areas. Before he is through, the surveyor is certain to find that a basketball coliseum filled with cheering, stomping, clapping fans is far above permissible noise levels. Perhaps he will even find that his secretary is using methanol in the office duplicator and carbon tetrachloride to clean her typewriter, without adequate ventilation in either case.

In general, a healthful working environment depends upon the concentration of chemical agents in the air, the level of the noise, the intensity of ionizing radiation and radiant heat, the temperature, and the illumination. Wherever materials are processed, some material will escape into the air in the form of dust, fume, mist, gas or vapor, unless the operation is carried out in an air tight system, which is not a usual circumstance around an educational institution.

Industrial Hygiene, as a program, employs the biologist, chemist, physicist, engineer, mathematician, and physician. The engineer and mathematician design the original systems. The biologist, chemist and physicist utilize these systems. The physician studies the effects of all systems, both good and bad, on man.

Proper ventilation takes much of the hygienist's time. Many times in the research environment, one never knows what toxic properties he is working with. Fume hoods should be monitored on a regular basis to insure safe handling of all toxic materials. Ken Fay, here at Calgary, has one of the better fume hood monitoring systems that I know of.

How many buildings on your campus have the exhaust outlets next to their "fresh air" intakes? Or have their air intakes next to the loading docks, where huge trucks park for "hours" with the motors running? Or the fume hood is located adjacent to a doorway, with its natural draft patterns? Or the fume hood located next to the room exhaust?

The industrial hygienist will work hand-in-hand with the campus sanitarian, many times on the very same projects or problems. At ISU, our Computer Science Program was having problems with employees complaining of an unbearable itch. The sanitarian was asked to investigate because of possible insect infestation. After numerous visits by the pesticide and entomology specialists, with no results and continued complaints by the employees, some of the experts began to say the problem was psychological. I was then called to investigate and, through researching, found that key punching operations send materials into the air, similar to the insulation that has caused all of us do-it-yourself carpenters to itch like crazy.

At ISU the sanitarian spends more time with external environmental problems and I with the internal problems. Epidemiology studies are done by both.

Agricultural and veterinary research are constantly working with pesticides or with various animals and their associated odors, diseases, and unsafe handling procedures. On our campus, we have had problems with employees becoming sensitized to Ascaris (roundworm) reproductive hormone secretions during dissections. We made recommendations that fume hood velocity be checked and corrected if necessary, and that employees use protective clothing, a barrier cream, and good personal hygiene to minimize contact with the Ascaris. We also suggested that the dissection process be done under water, in the fume hood.

Chemistry knowledge will be very valuable to the hygienist. Hazardous waste problems can be overwhelming on campus and many departments attempt to take care of their problems by unlawfully dumping their waste in landfills or the sewer system. Yes, some organic solvents do start fires this way. Legally, the U. S. Department of Transportation will not allow you to transport unknowns on public highways, so you do have a problem immediately! How do you eliminate the hazardous waste? Most landfills are now outlawed by EPA. Incineration does take care of many types of waste with the proper scrubbers attached to the incinerator. The industrial hygienist must be certain, while handling these wastes, that he has proper protective equipment and that he is obeying the OSHA and EPA laws.

A thorough industrial hygiene program will be involved with reviewing building construction to prevent future industrial hygiene problems, such as improper placement of exhaust runs, placement of air-intakes next to loading docks or three feet from an exhaust outlet, or perhaps location of an exhaust directly over a greenhouse. It will be involved with educational programs, total pre-OSHA building inspections, review of accidents, and working closely with health services, space and scheduling, engineering planning and physical plant departments. I have heard it said that the industrial hygiene office is a "garbage can for stray information."

The role of the industrial hygienist is to develop an industrial hygiene program evaluating existing campus occupational health hazards and exposures to harmful substances and agents, and improving the employee environment. The University conducting research in various disciplines will be able to justify a program on these activities alone. A successful industrial hygiene program will be well worth the expenditures put forth, could save money for the remodeling of inadequate conditions on campus, and could save many lives.

The campus industrial hygiene program, by becoming involved with each of the fields I have mentioned, thus becomes itself a truly unique profession.

FIRE ALARM, VOICE AND FIRE FIGHTERS EMERGENCY COMMUNICATIONS SYSTEM

Keith Lush
Simplex International Time Equipment Co., Ltd.

Ladies and gentlemen on behalf of SIMPLEX INTERNATIONAL TIME EQUIPMENT COMPANY it is my great pleasure to be here today to participate in your Annual Conference on Campus Safety.

I am not here to sound an alarm, but the need for safety measures should never be slighted and this Conference is to be congratulated for its great concern and humane endeavor in promoting activities beneficial to all mankind (or, in keeping with the latest terminology, all "personkind").

Each year accidents kill or maim more individuals in our society than any disease. Viewed in this respect, an accident could be said to be our greatest enemy against which we must always stand on guard. Accidents never discriminate. They strike anyone, anytime, anywhere.

My work involves safety devices directed against a particular type of accident - that caused by fire, or what V. Gordon Childe has referred to as "the puzzling process of burning - the mysterious power of heat." (1) In their unpredictability and wild ravishing, fire accidents are most puzzling and mysterious, sometimes warning us with smoke or hot spots, and often striking with the speed of lightning.

There are approximately 1,000 residential and apartment fires each week in Canada, with human losses running high in the hundreds and dollar losses in the hundreds of millions. (4)

In 1974 there was a total of 6,335 fires in the city of Toronto alone, 612 of these were in vehicles - cars, subway, etc., -- 1,849 involved rubbish and grass, while 3,874 caused varying degrees of destruction in buildings. Thirty-four Toronto citizens died last year as a result of fire while 243 were injured. There were 168 persons requiring hospital treatment. An estimated loss of six million, five hundred and eighty-two thousand and fifty-five dollars ($6,582,055.00) has been totaled from fire destruction in Toronto in 1974. (2)

As with any accident, a pertinent factor in the control of unwanted fires is the time element. When disaster strikes, time is at a minimum. Individuals become quite apprehensive, often panicking. In such a state of mind one can be handicapped in making skillful decisions. It is, therefore, essential to be well-informed at all times of methods to control this powerful physical force.

The control of fire emancipates human beings from the bondage of one of the mightiest forces of nature. SIMPLEX INTERNATIONAL TIME EQUIPMENT COMPANY specializes in fire alarm equipment to assist with this endeavor.

Those vested with the responsibility of insuring that proper safety devices are maintained in buildings are guided in their endeavors by codes.

You are probably quite familiar with the U.B.C. - Uniform Building Code, Section 1807; B.O.C.A. - Basic Building Code, Section 432, S.B.C. - Southern Building Code, Section 518, N.B. - National Building Code of Canada, Section 2, 3, 6, 9. The N.F.P.A. - National Fire Protection Association has made recommendations concerning specific requirements and equipment for usage in high-rise buildings.

The unfortunate thing about codes, however, is that they are only binding if enacted into law, in the same manner as other legally-enforced behavior patterns. Hence, these codes do not represent universally adopted methods of protection against fire. Some buildings are located in communities which do not have law-enforced codes or else are guided by other codes and, as a result, standards differ from community to community. The non-enforcement of codes presents one of the fundamental problems in coping with fires in high-rise buildings. However, new codes are being written. For example, about one year ago, June 1974, the Toronto City Council passed a bylaw requiring early warning devices, or "Products of Combustion Detectors" of the ionization type, be installed in all buildings comprising three to five apartments, thereby permitting an automatic alarm to be sounded as soon as a fire starts, even though human senses may not detect it. In November the Housing Standards Bylaw was amended by Council to require that all lodging houses in Toronto city be equipped with fire detectors. (2) As a code is useless if not enforced, it is hoped that all communities will enact similar codes into law as soon as possible.

Community responsibility has always been a principle element in the history of fire protection. Early colonists brought with them, from Europe, laws requiring every property owner to lend assistance whenever a fire signal was sounded.

As communities became larger and more complex, this arrangement became inadequate and was eventually replaced by volunteer fire companies. Then, local governments developed fire departments. Modern equipment became more widely used and fire protection became more effective, with many North American cities surpassing those of Europe which had introduced the early laws and equipment. (3)

Following a short movie which we will view at this time, I will explain some of our equipment - the Fire Alarm and Fire Fighters Emergency Communication Systems, as produced by SIMPLEX INTERNATIONAL TIME EQUIPMENT COMPANY.

Although it's not "The Towering Inferno," this film deals with a situation that could occur in a high-rise building when a fire strikes.

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As the film has illustrated, numerous problems must be coped with when a fire strikes a high-rise building. More and more of these buildings are being erected and, as they increase in number, so too does the concern for adequate and efficient safety measure within them.

The size and shape of the building can be a help or a hinderance when fire strikes. People may become trapped on upper floors of the structure.

Open passageways quickly fill with smoke and poisonous gases, blocking the way to safety. Stairwells may or may not be easily accessible. Elevators in large high-rise buildings may stop between floors trapping passengers. On the other hand, a building may be so constructed that a fire can be contained in a specific area. The type of materials with which a building and its contents are constructed may create tragic problems. Today, many items are composed of synthetic materials which, when ignited, give off highly poisonous gas. Inhalation of such gases cause more deaths during a fire than do the flames. Hence, individuals may be some distance from the fire and still become fatal statistics. Effective early warning devices are mandatory to prevent such disaster.

I think everyone is familiar with fire alarm systems and how imperative it is to sound the alarm at the earliest possible moment once evidence of a fire has been detected. The alarm should be effective to the degree that it alerts all persons in the area of the fire. In the past, fire alarm meant the ringing of bells and horns. However, confusion can arise from the use of this type of alarm in a large area compl[illegible]. Since the equipment must be tested periodically to assure its working ability, individuals within the building become conditioned to hearing the horn or bells sounding when there is no evidence of an emergency. Hence, when an alert is sounded, the ringing of bells or horns may be disregarded by those who do not receive more tangible evidence of the impending danger.

SIMPLEX INTERNATIONAL recommends the utilization of speakers, instead of bells, as early warning devices. Not only do speakers alert of impending danger by sounding an alert tone, but they also permit instructions to be transmitted to the occupants, regarding evacuation procedures.

It is also our recommendation that this be a dedicated system used only for fire alarm and voice evacuation. It should not be used as a background music or P.A. system as it has been our experience that a system used for music and P.A. is often a target for malicious damage of one kind or another.

Irrespective of the size and nature of a fire, the first and most vital act is that of evacuation of the area once an alert has been sounded. No fire is too small or too insignificant to permit individuals to remain inside while this curious chemical change called fire is occurring. In a high-rise building, exits and stairways are often few in number while the occupants are usually numerous. Hence, evacuation of a high-rise may be quite a complicated procedure. Individuals may also create limitations during an evacuation by panicking and shoving in congested passageways. It is, therefore, mandatory that a controlled and orderly manner characterize the procedure even though evacuation from a high-rise building may require more time than is desired. Evacuation should commence immediately upon detection of a fire, smoke or abnormal heat. Usually the floor on which the fire is located is evacuated first, along with the floors above, followed by the floors below the problem area.

Due to the size and complexity of a high-rise building, the sound system, to be of optimum effectiveness, must be zoned, in order that instructions can be given to individuals on each floor or group of floors, depending on the arrangement of the building and the nature and locale of the fire.

Of course, an alarm system which, for some reason or other, becomes inoperative, is absolutely useless. Since any machine can become defective if not properly cared for, we at SIMPLEX advocate this sound system be supervised for shorts and opens in wiring. If, for any reason, a speaker is removed from the system, this, too, must be indicated to those responsible for fire detection and protection, for the building.

The introduction of voice signaling circuits for fire alarm evacuation created new problems for manufacturers of fire alarm control equipment. The new methods differ considerably from the old standards of signaling. New control equipment had to be designed such as power amplifiers, pre-amplifiers, microphone pre-amplifiers, tone oscillators, etc. Requirements, concerning complete supervision of the system, had to be met. This includes supervision of the wiring in the building as well as the control equipment. We consider these measures necessary to guarantee that a reliable control system is furnished to all our customers.

SIMPLEX INTERNATIONAL TIME EQUIPMENT COMPANY provides a sound system of the highest quality. Our speakers consist of fire resistant cones and are insect proofed and covered with a grill to protect them from any damage that might otherwise occur.

In providing fire alarm systems in high-rise buildings, our company aims to provide optimum flexibility in the use of the control equipment. Individuals, responsible for the care of the building and its occupants, can use our control equipment to instruct all those within the structure, as well as giving specific instructions to those in the effected area, or to the personnel trained and responsible for instituting fire fighting procedures. Instruction can, thereby, be transmitted, by the operator at the control centre, to any area of the building, and can be readily understood by those to whom it is directed.

In conjunction with this one way voice communications system, SIMPLEX INTERNATIONAL also recommends the use of a fire fighter two way private telephone system. Although this is an entirely separate system, the controls are usually installed in the same location as the fire alarm and voice evacuation system controls. This two way telephone enables conversation between officials at the control centre and anyone in selected areas of the building. When the remote telephone is removed from its cradle, a visual and audible signal is received at the control centre, indicating someone at the location wants to speak with the control centre. This audible and visual telephone signal does not work in reverse since the control operator can give the necessary signal by means of the voice evacuation system, that is, by verbalizing the request for a private conversation. This system is, therefore, of more significance to the official fire fighters.

Time is at a premium during a fire and the sooner the fire is detected the more time will be available to assist in controlling the situation.

The fire alarm control panel also monitors devices for early combustion detection which includes heat detectors, smoke detectors and manual stations. In the event a fire occurs, this equipment not only sounds the alert, but controls the air handling system, the smoke control system, and returns all elevators to the ground floor.

In conclusion, I would like to say that we of SIMPLEX INTERNATIONAL TIME EQUIPMENT COMPANY, as manufacturers of fire alarm equipment, are eager to communicate with you and to cooperate fully, at the earliest possible time, in all projects related to fire alarm systems. We have found that engineers and architects, who assume great and numerous responsibilities in the construction of high-rise buildings, are not always completely aware of local municipal requirements. As a result, controls, which cannot be used, are sometimes specified in their plans. It is, therefore, important, when construction of a new building is being planned, to consult with the local representative of a fire alarm manufacturer who will be aware of the prevailing specifications for controls in the concerned area.

SIMPLEX INTERNATIONAL TIME EQUIPMENT COMPANY has approximately 170 offices in the U. S. A. and 22 in Canada, - all staffed with sales and service personnel eager to assist you. With good communication between you, the customer, the engineer and the fire alarm manufacturer, many problems will be offset or resolved at the earliest possible time, and before improper steps have been taken.

It has been a pleasure talking to you today and I look forward to being of assistance to you in the future.

REFERENCES

(1) - Childe, V. Gordon, MAN MAKES HIMSELF, (The New American Library of World Literature, Inc.) 1963.

(2) - Toronto Fire Department 1974 Annual Report.

(3) - Glaab, Charles N., and A. Theodore Brown, A HISTORY OF URBAN AMERICA. (The MacMillan Company, New York), 1967.

(4) - Joint Fire Prevention Publicity Committee, Inc., 34 Front Street West, Toronto, FIRE PREVENTION NEWS '75, & HOME HAZARD WARNINGS.

THE DESIGN AND OPERATION OF THE UNIVERSITY OF BRITISH COLUMBIA CHEMICAL WASTE DISPOSAL FACILITY

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Introduction

Documented history of the Chemical Waste Disposal Facility at the University of British Columbia dates back to December, 1969, when Dr. B. A. Dunell was appointed chairman of the President's Committee on the Disposal of Dangerous Chemicals. The terms of reference of the Committee were quite broad and the substances to be investigated from the disposal point of view ranged from chemicals to microorganisms, excluding only radioactive materials.

The late sixties, you will recall, were the times when a lot of people were just becoming aware of pollution problems and concerned about their impact on the environment. The "in" expression was ecology. Pollution control legislation and regulations were being enacted by various regulatory bodies including our own provincial (1) and municipal (2) authorities. Various anti-pollution groups were getting organized and becoming more vocal. There was only one thing lacking and that was some practical advice on methodology to be able to comply with the new rules and regulations.

This was the atmosphere that prevailed at the time when the Committee began its work, and the pressure was on to come up with some solutions in a reasonable length of time.

Committee Findings

In order to determine the nature and magnitude of the problem at UBC attributable to dangerous materials, the Committee contacted various departments at the University to ascertain what hazardous materials were being purchased, used, stored and how disposed of.

The replies to the questionnaires, summarized in Table I, showed that the greatest problem was the disposal of 53,000 lbs. of chemicals, mostly organic solvents, every year.

Some suggestions that the Committee considered were a modification to the existing pathological incinerator to burn some of the chemicals--a solvent recovery process--disposal into pits, etc. Most of the proposals were either too expensive or impractical for other reasons. None offered a total solution. Inquiries were directed to 20 Canadian and American universities to see how they coped with similar problems. Some of the replies were quite lengthy, but there did not seem to be any ready made solution that we could copy.

Early in 1970 I became aware of the existence of the Committee and some of their deliberations. I was informed that in one or two of the replies received from other universities, among them the University of Toronto, there was a reference to using the services of a private operator to dispose of solvents. I contacted my colleague Bill Ridge at the University of Toronto and from him learned that their contractor was using an incinerator built by Trecan(3).

The Committee was informed of this and was able to study this method of disposal in greater detail. By the end of 1970 the Committee issued the first of two reports. Among its findings was a recommendation that the University purchase a liquid waste incinerator, that a solvent collection system be initiated, and in the last sentence suggested that the University could benefit from the services of a pollution control officer. Since I was responsible for the disposal of one class of dangerous materials, namely radioisotopes, the authorities decided that the disposal of all hazardous materials should be under my jurisdiction.

Planning Stage

Construction at our University is handled through the Department of Physical Plant. Acting upon the Committee's report, the President's Office asked this Department to look into the costs and construction details of a liquid waste incinerator. The Department of Physical Plant hired a firm of consultants (4) to explore more fully the engineering aspects and to recommend suitable equipment.

Except for greater detail, the studies undertaken by the consultants and their eventual recommendations were virtually the same as those of the Committee. The consultants recommended the purchase of a Trecan Sub-X incinerator, modified by the addition of a venturi scrubber (5) to remove particulates from the effluent air. A tank farm and a waste water settling tank were also to be added.

The consultants' report specified that the disposal site would be improved and expanded to accommodate not only the existing pathological incinerator but also the proposed Sub-X unit, an open pit incinerator and a chemical degredation unit. In May, 1971, these proposals were reviewed by the Committee which then issued the second report recommending that the University proceed with the project as outlined by the consultants.

The Board of Governors approved the project and allocated the necessary funds. Many months dragged by before the disposal facility got off the drawing board. This coupled with a dispute and work stoppage in the construction industry, it was late December, 1972, before the Trecan people first fired up the incinerator. For various reasons, several more months went by before the unit was completely operational.

Operational Stage

From the very beginning it was obvious that chemical wastes, especially organic solvents, should not be allowed to accumulate in the various labs. Regardless of what disposal methods would eventually be used--the collection system would be virtually the same. Steps were taken to collect solvents as soon as possible.

Studies showed that five gallon containers (initially of mild steel but currently they are of heavy plastic) would be placed in strategic areas to collect the solvents. On a regular basis, these containers would be collected and new ones left in their place. Currently this is on a weekly basis.

Five hundred jerry cans were purchased and collections began on a regular basis in June, 1971. The containers were emptied into 45 gallon steel drums located in a fenced, open air storage area. Originally only solvents that contained no halogens were collected and stored. When the incinerator became fully operational in mid 1973 the collection of halogenated solvents were carried out as well. It required several months of operating the Sub-X unit to process all of the solvents that had accumulated over a two year period.

Figure 2 is a simplified flow sheet, indicating the path taken by solvents once they reach the disposal site.

Material is delivered to the site in a special truck which has racks to accommodate the disposal containers. A high capacity transfer pump empties these containers into one of four storage tanks. The containers are tagged to indicate the nature of the contents and the segregation at the tank farm is roughly into three types: organic solvents, halogenated organic solvents and oils. Mixing is done in the blend and feed tank. This blending is necessary to maintain the appropriate heat output of the waste to cut down on the use of the auxiliary fuel. From the feed tank, the waste is pumped at high pressure at a rate of 25 gallons per minute to the Sub-X unit, the operation of which will be discussed shortly.

The combustion products are scrubbed and cooled before being released to the atmosphere via the exhaust stack. These gases are monitored to ensure that they comply with the appropriate controls as set out in our Operating Permit.

The waste scrub water, and indeed all of the water on the site, drains into a sump and then is pumped into a settling tank before being discharged to the sanitary sewers. This water is also monitored.

The heart of the disposal facility is the Trecan Sub-X LV-3 incinerator scrubber and is shown in Figure 3.

The burner is similar to that of any oil furnace. Waste solvents pass through an inner pipe and are sprayed through an orifice into a mixing chamber. The orifice is drilled 5/64" for 30 GPM flow.

The atomizing air is fed through the outer pipe and is forced through apertures into the chamber, where thorough mixing and emulsification takes place. Atomization occurs by the passage of this mixture through the holes in the tip. For our purposes there are seven such holes, drilled 7/64" at 60°. This produces the desired flame pattern, in this instance a short vortex.

The auxiliary fuel is natural gas which is adjustable to maintain a constant heat output from the burner. Combustion air is supplied by a large blower.

The flame at approximately 2,700° F is directed downward through an inverted stack or downcomer. The combustion products are bubbled through water and as they rise are sprayed with more water, up to 165 gallons per minute. This action cools the gases to 120° F or less and also washes out any HCl. The gases then are dried in the demister and particulates are removed in the venturi scrubber.

One of our modifications was the addition of a pH meter followed by the installation of two additional sprayers which introduce soda ash into the scrub water to maintain a neutral pH value. The original idea of percolating the water through limestone chips was not efficient. More recently we added a thermocouple to check the flame temperature and some flow gauges.

Now that we have most of the component problems sorted out the unit works surprisingly well. We experienced some costly problems with undersized components such as the air compressor and relays. Probably most frustration arose from trying to keep the feed pump operational. The varied mixture of solvents just could not be handled by any pump for more than a few hours. Finally a very cheap oil pump was introduced and this is replaced on perhaps a monthly basis. Hopefully we shall also find a suitable filter to introduce in the feed line.

Because our unit is outdoors there have been some problems with instruments sweating as well as relays overheating in the sun. During several cool nights in the winter water was drained from exposed lines to minimize the risk of freezing.

In spite of the intermittent use to which this incinerator is put, the anticipated problems with the refractory linings have not arisen.

Small quantities of dry chemicals, from time to time, are burned in the open pit incinerator. This is essentially a concrete box lined with refractory material on the inside and steel on the outside. The floor is covered with sand or vermiculite, and on this is placed the material to be incinerated. A natural gas flame is ignited with a delay relay to give the operator time to vacate the area for safety reasons. Over fire air is also provided. Only known chemicals are burned here. No surprise packages are permitted to be delivered to the site.

Two small tanks are also available for neutralizing highly corrosive materials that for various reasons cannot be handled in the labs.

Summary

Our disposal facility has proven itself to be capable of handling most of our wastes both biological and chemical. It also is most useful to dispose of the large volumes of liquid scintillation fluids, and to a lesser extent of other low activity radiological wastes. There is time available on the units to process wastes from other educational institutions and to a limited extent from industry. Some research is currently under way to see whether pesticides can be destroyed in the Sub-X unit. So far the indications look promising as the biological monitors, in this instance, trout and mosquito larvae, have all survived.

References:

1. Province of British Columbia, Pollution Control Act 1967, (1967, Chapter 34; 1968 Chapter 38; 1970 Chapter 36)

2. Regulations Pursuant to the Greater Vancouver Sewerage and Drainage District Act Governing the Admission of Wastes Into Sewers. June 18, 1970.

3. Trecan Limited, 4540 Dixie Road, Mississauga, Ontario.

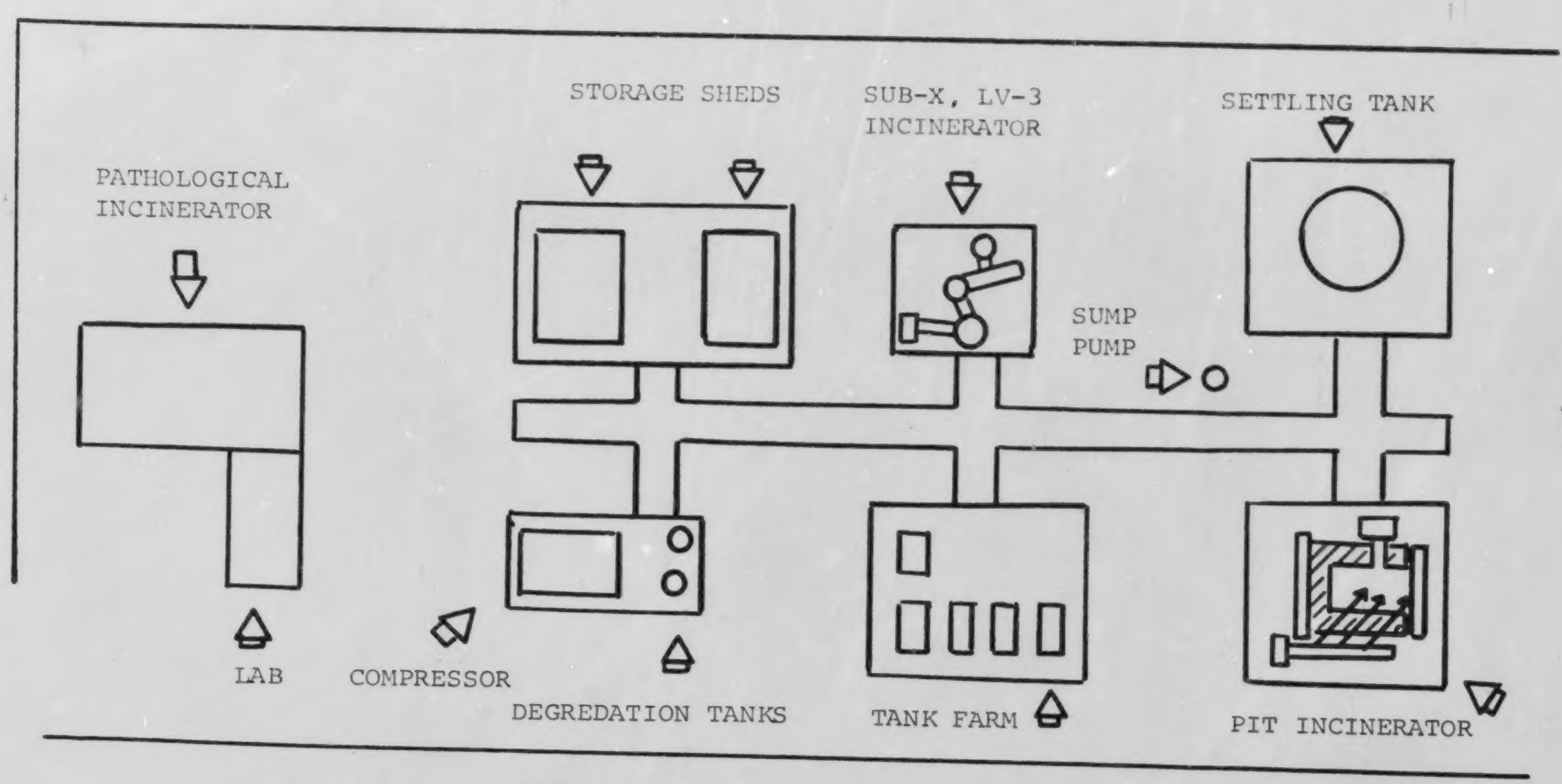
4. B. H. Levelton & Associates Ltd., 1755 West 4th Avenue Vancouver, B.C.

5. Oriclone Venturi-Type Scrubber, The Ducon Co. Ltd., 4475 S.W. Scholls Ferry Roads, Portland, Oregon.

TABLE I

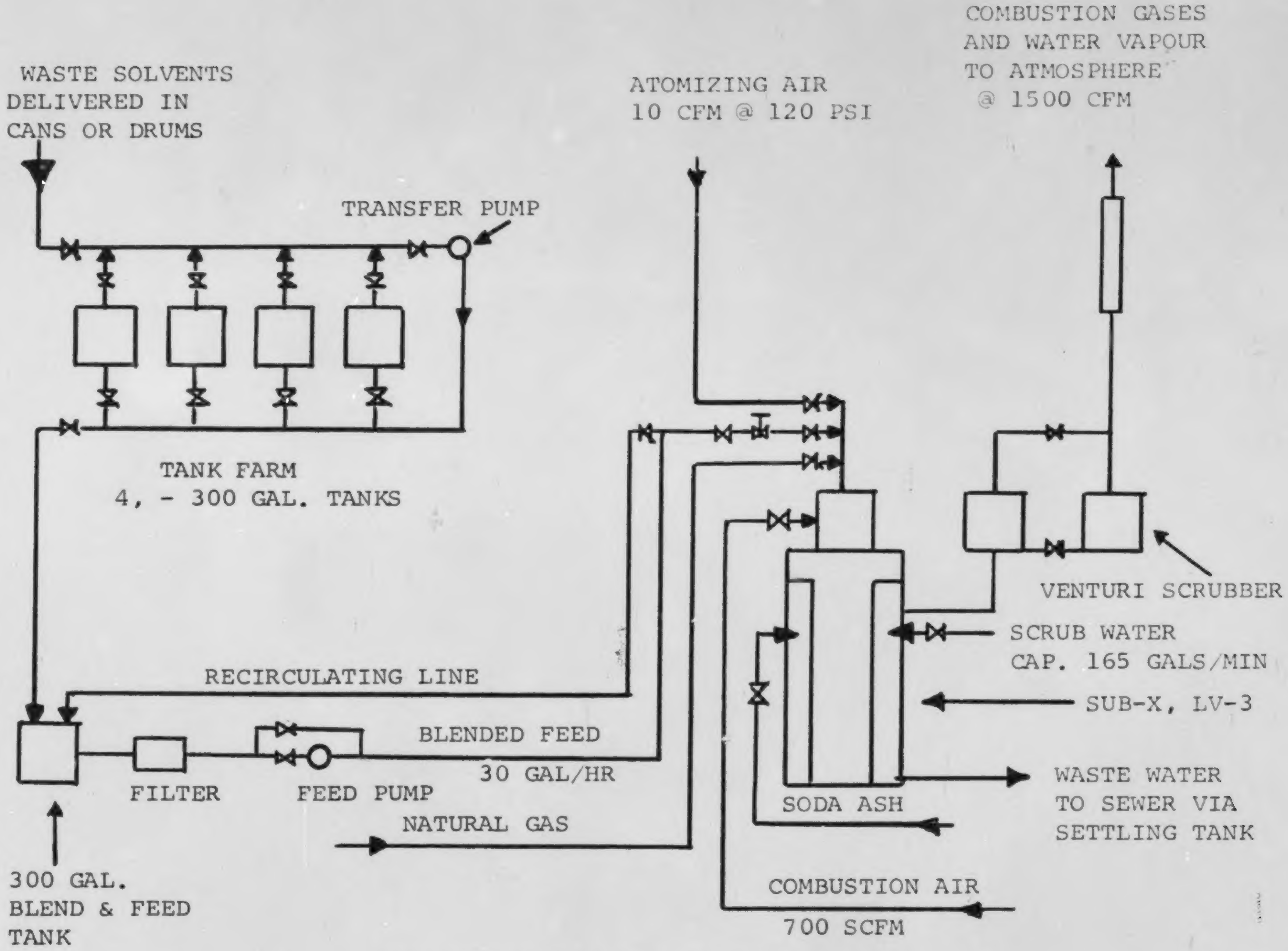
SUMMARY OF HAZARDOUS MATERIALS THAT REQUIRE DISPOSAL AT U.B.C. PER YEAR

Diethyl Ether	5,000	lbs.
Acetone	9,000	lbs.
Benzene	4,800	lbs.
Ethyl Alcohol	6,400	lbs.
Ethyl Acetate	1,000	lbs.
Kerosene	500	lbs.
Methyl Alcohol	4,800	lbs.
Petroleum Ether	4,000	lbs.
Toluene	1,800	lbs.
O-Xylene	1,000	lbs.
Trichloroethylene	1,000	lbs.
n - Butyl Alcohol	700	lbs.
Varisol	600	lbs.
Motor Oil	2,500	lbs.
Paint Thinner	2,500	lbs.
Gasoline	400	lbs.
Methyl Isobutyl Ketone	400	lbs.
Carbon Tetrachloride	2,000	lbs.
Chloroform	8,000	lbs.
TOTAL:	56,000	lbs.


STORAGE SHEDS
SUB-X, LV-3
INCINERATOR
SETTLING TANK
PATHOLOGICAL
INCINERATOR
SUMP
PUMP
LAB
COMPRESSOR
DEGREDATION TANKS
TANK FARM
PIT INCINERATOR

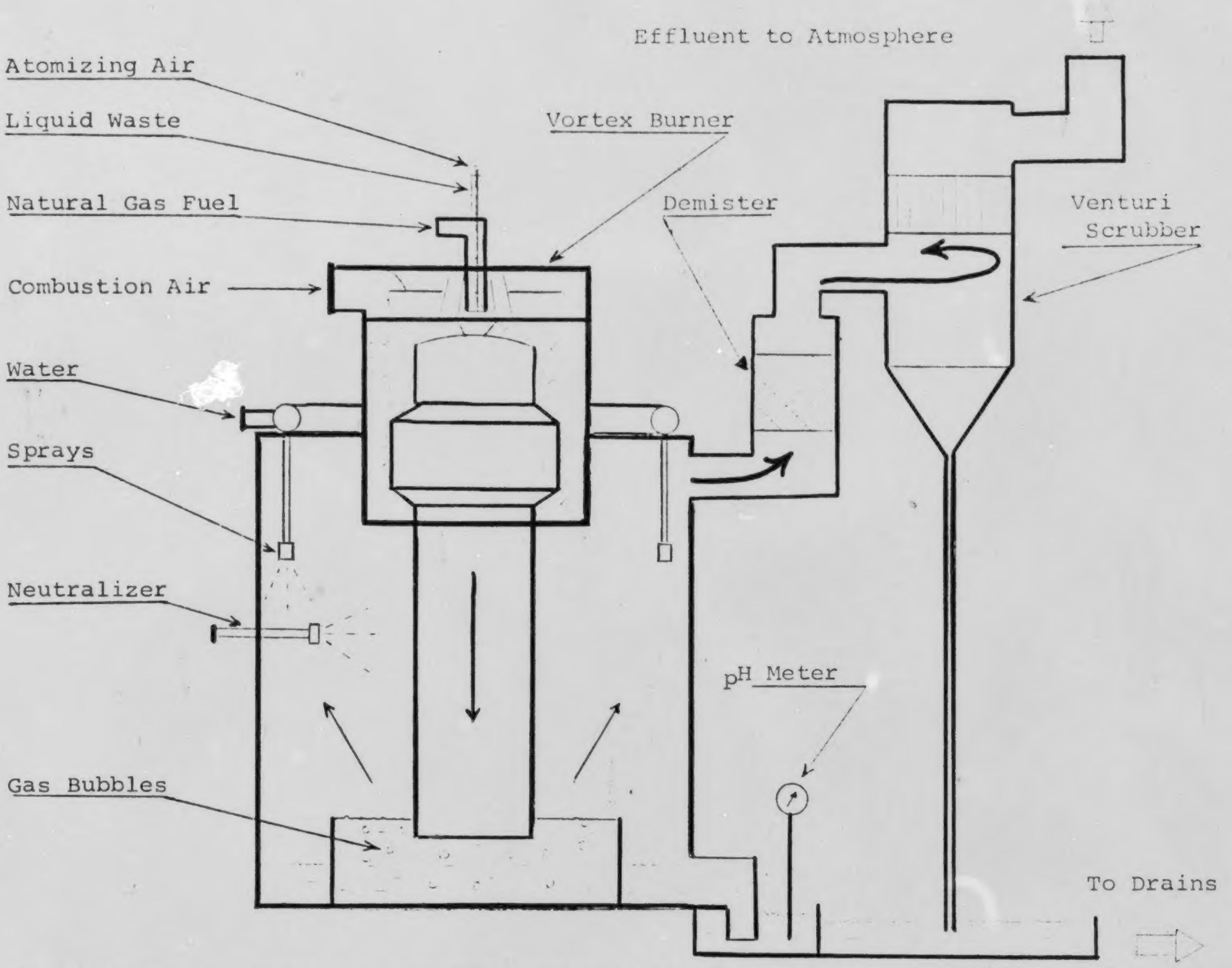
THE UNIVERSITY OF BRITISH COLUMBIA
CHEMICAL WASTE DISPOSAL FACILITY SITE LAYOUT

FIG. 1


WASTE SOLVENTS DELIVERED IN CANS OR DRUMS
TRANSFER PUMP
TANK FARM 4, - 300 GAL. TANKS
ATOMIZING AIR 10 CFM @ 120 PSI
COMBUSTION GASES AND WATER VAPOUR TO ATMOSPHERE @ 1500 CFM
VENTURI SCRUBBER
SCRUB WATER CAP. 165 GALS/MIN
SUB-X, LV-3
WASTE WATER TO SEWER VIA SETTLING TANK
RECIRCULATING LINE
BLENDED FEED
30 GAL/HR
FILTER
FEED PUMP
NATURAL GAS
SODA ASH
COMBUSTION AIR
700 SCFM
300 GAL. BLEND & FEED TANK

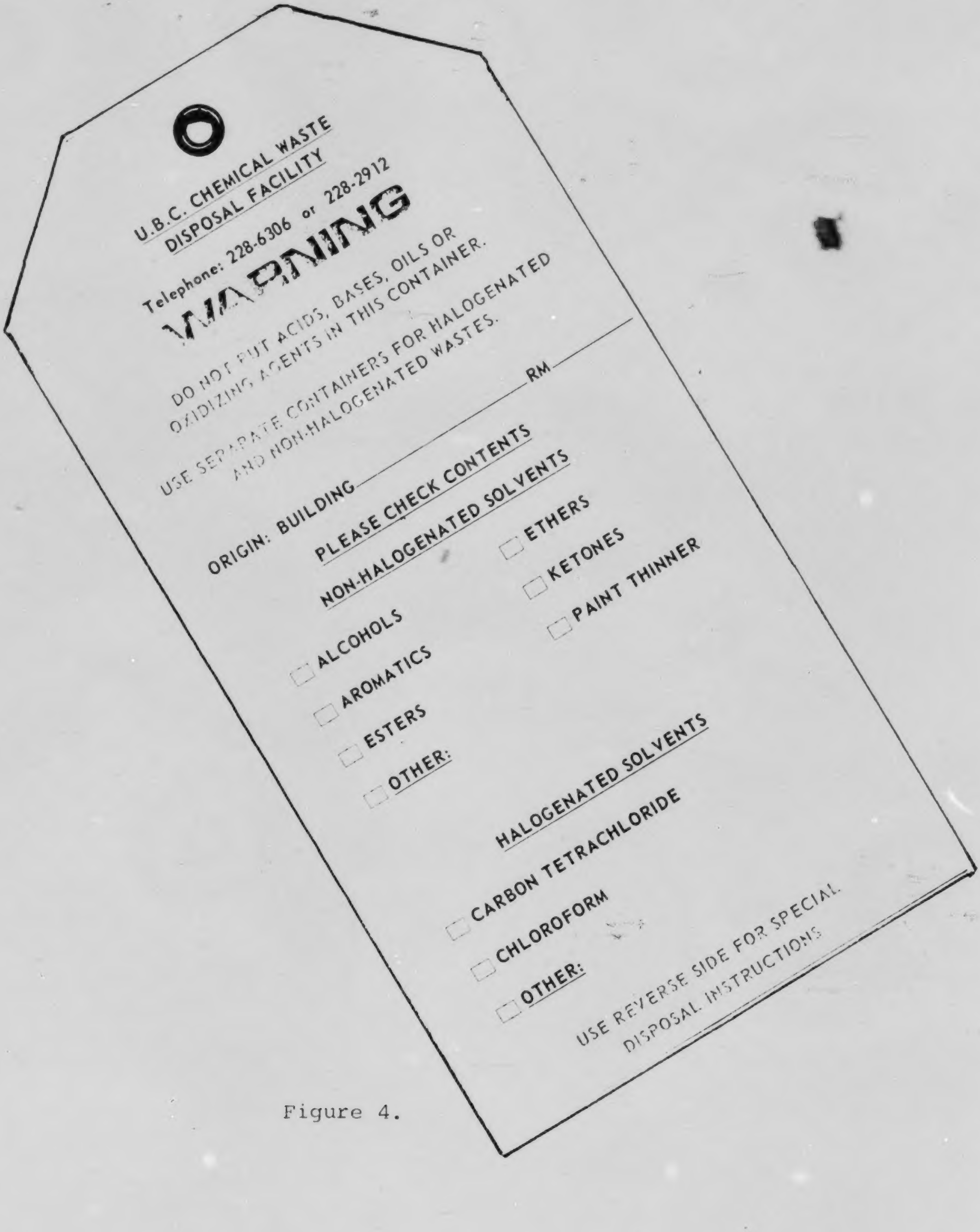
THE UNIVERSITY OF BRITISH COLUMBIA
CHEMICAL WASTE DISPOSAL FACILITY SIMPLIFIED FLOW SHEET

FIG. 2


Effluent to Atmosphere
Atomizing Air
Liquid Waste
Vortex Burner
Natural Gas Fuel
Demister
Venturi
Scrubber
Combustion Air
Water
Sprays
Neutralizer
pH Meter
Gas Bubbles
To Drains

THE UNIVERSITY OF BRITISH COLUMBIA CHEMICAL WASTE DISPOSAL FACILITY
(Sub-X Incinerator by Trecan, Ltd.)

FIG. 3



U.B.C. CHEMICAL WASTE
DISPOSAL FACILITY
Telephone: 228-6306 or 228-2912

WARNING

DO NOT PUT ACIDS, BASES, OILS OR OXIDIZING AGENTS IN THIS CONTAINER.

USE SEPARATE CONTAINERS FOR HALOGENATED AND NON-HALOGENATED WASTES.

ORIGIN: BUILDING ____ RM ____

PLEASE CHECK CONTENTS

NON-HALOGENATED SOLVENTS

☐ ALCOHOLS
☐ AROMATICS
☐ ESTERS
☐ OTHER:
☐ ETHERS
☐ KETONES
☐ PAINT THINNER

HALOGENATED SOLVENTS

☐ CARBON TETRACHLORIDE
☐ CHLOROFORM
☐ OTHER:

USE REVERSE SIDE FOR SPECIAL DISPOSAL INSTRUCTIONS

Figure 4.

"ACTION AND INDOCTRINATION - TWO SIDES OF A CHEMISTRY DEPARTMENT SAFETY PROGRAM"

(An illustrated presentation)

Dr. Stanley Pine
Department of Chemistry
California State University
Los Angeles, California

The first consideration in a chemistry department safety program begins with the facility. Building safety design is in large part controlled by local building and fire ordinances. Although this might take care of our safety concerns for most university buildings, the special nature of a chemistry building introduces many additional considerations.

Chemical storage and related fire danger is extremely important. We make use of an automatic CO_2 system in our chemical storage area in case of fire. Dispensing of chemicals and particularly flammable solvents necessitates a special fire safety room, in our case also equipped with automatic ventilation and CO_2 fire extinguishing system.

Fume hoods are one of the major safety investments in a chemistry building. Various designs are available from all stainless steel units with special filters for work with radioactive substances to large walk-in conventional hoods. We have found that the vertically moving hood window front can double as an excellent working safety shield if the window is made up of horizontally sliding sections about twelve inches wide. An always present problem is that hoods seem to become a storage area for all kinds of chemicals and apparatus and can be a safety hazard rather than help.

A chemistry building can easily have thirty or forty hoods on any given floor. The problems of hood venting thus become quite serious. A fundamental rule is that the blower units be at the end of the hood duct (usually on the building roof) rather than at the hood. This insures that positive pressure will never occur in the ducts and minimizes possible leaks.

Venting on the roof can present an esthetic problem because of ugly vent fans. On our campus this was solved by building a wall around the vents. However, this has its safety hazards also for heavier than air fumes may get trapped and present a hazard to building maintenance workers.

A related design concern is the location of the building air intake system. This must be located away from the hood exhaust. The aerodynamic considerations are quite tricky especially where prevailing winds are inconsistent. In this regard it is important to emphasize that building air should never be recirculated. This is an architectural procedure which makes good economic sense in an air conditioned office building but not in a chemistry facility.

In student laboratories the space between laboratory benches is of both safety and economic concern. We find that five feet is a suitable isle width if students are to work back to back. This means that the undergraduate laboratory will have a great deal of "unoccupied" floor space, an economic concern to most administrators.

The provision for doors opening into a corridor is of particular concern when people may be carrying dangerous chemicals. Even a window lookout does not seem to stop the many near misses as doors are opened into students walking in the hallway. A design solution is to require that doors opening outward into a corridor be recessed at least 75% of their width.

The potential for explosions in some chemical reactions requires that the safety oriented chemistry building hav[illegible]ecial area for carrying out dangerous reactions. We make use of a spe[illegible] compartmentalized room constructed of heavy steel and equipped for remote control and observation. The fourth wall of the room is louvered as a means of pressure relief.

Once the major design features are completed, safety equipment within the building must be considered. Laboratories should have a readily available overhead safety shower. Small hand safety showers are also particularly useful for minor spills and as eye baths.

The availability of other types of small safety equipment becomes a touchy problem because of vandalism and theft. A compromise places first aid and fresh air equipment in safety cabinets with break-a-way locks or in a storeroom available during laboratory hours. Readily available campus emergency telephones are a minimum safety consideration in chemistry laboratories.

A very simple vandalism safety device which we see in industry but seldom in the academic laboratory is a lead safety seal on fire extinguishers. The seal must be broken to use the extinguishers. Once the seal is broken, whether through student horseplay or actual fire usage, the extinguisher is refilled and sealed. You can be sure that a sealed extinguisher is ready for use if needed.

One of the chemistry safety problems we have not yet satisfactorily solved is what to do with waste chemicals. Most students simply pour waste down the drain. This is clearly not the answer. The use of special waste chemical containers to collect material for later commercial disposal does not work with a large and always changing student population. Cross contamination of wastes in the containers can be disastrous. At this time it is a largely unsolved academic problem.

I have labeled the second aspect of the University safety problem INDOCTRINATION. This of course is safety education, a major goal of our (and I hope all) safety programs. Our students will graduate into one of the economically most important industries, but potentially one of the most dangerous (although statistically it is one of the safest industries). Safety education must go along with chemical education from the beginning.

Unfortunately we cannot follow usual academic pedagogy and design simple accidents to go along with beginning courses. Sulfuric acid causes serious burns to a freshman student as well as an advanced graduate research student. Of course we avoid use of dangerous chemicals at the freshman level as much as possible but their complete elimination is not possible.

I always begin my school safety talk with the question (and title of the talk) WHY SAFETY? To get everyone's attention we begin with an excerpt from a film (produced by Imperial Chemical Industries) which dramatically shows a laboratory explosion involving a Grignard reaction. All sophomore organic chemistry students know of the very important synthetic reaction developed by the French chemist Victor Grignard (Nobel prize in chemistry in 1912). Almost all students will carry out this reaction in the first organic laboratory class. It is potentially one of the more dangerous reactions done at this level because boiling diethyl ether is the reaction solvent. The real message of the film comes through as the supervisor surveys the damage of the explosion and says, "I don't understand, we've done it hundreds of times before - it's perfectly safe!"

A first step in the safety education is to be sure that students know what they are to do in an experiment. The National Safety Council tells us that most accidents are caused by unsafe practices. Numerous accidents result from students not knowing the names of their scientific laboratory apparatus. Use of the wrong piece of equipment can be disastrous. Just as small children must learn the alphabet before they can spell and read, the chemistry students must know their apparatus before they can properly and safely use it.

A good analogy is related by an old vaudeville comedy routine - trying to tell someone how to play baseball who has never seen or heard of the game. What is a bat (an animal living in caves and frequenting horror movies), a base (the bottom of a hill or the support for a TV set, or for the chemistry student an alkali). I think you get the point!

Knowing the danger of the chemicals and solvents to be used in the laboratory experiment is an important beginning for safety awareness. I relate the statement of astronaut Frank Borman when testifying at a congressional hearing into the death of three fellow astronauts in a fire within their space module during training:

> "None of us were fully aware of the hazards of when you combine pure oxygen with combustibles and then a source of ignition. This is the trap into which we fell."

Even in this most carefully planned space program a basic consideration of one of oxygens chemical properties was momentarily forgotten.

A slogan by the Manufacturing Chemists Association best exemplified this:

> "Chemicals in any form can be safely stored, handled, or used if the physical, chemical, and hazardous properties are fully understood and the necessary precautions including the use of proper safeguards and personal protective equipment are observed."

The use of basic protective equipment must begin with the students' introduction to the chemistry laboratory. Eye safety is our primary emphasis. In addition to a discussion of eye protection devices, the students view the film "Eye and Face Protection in the Chemistry Laboratory" by G. N. Quam of Villanova University. It is probably the best laboratory safety film currently available and leaves a very real and positive impression with the students. Of course, in this as with all safety programs, the result is only as effective as the persons who promote it. Instructors who do not wear their glasses at all times in the laboratory class cannot expect students to follow the rules either. It takes a rather rigid approach to make this aspect of the program work.

The film is one approach, but real safety examples always work best with the students. A cracked pair of safety glasses that a research student was wearing when an explosion occurred usually raises some gasps. The ceiling in one of the beginning organic laboratories is a close at hand illustration of the reaction that got out of control. Most startling is my example of metal sculpture. Two gas cylinders originally tested at 1800 psi were "artistically" ruptured and bent by a "safe" fluorination reaction which got out of control. As the clincher I show a photograph of one of our own students whose face was peppered with glass in a laboratory explosion. Luckily he was wearing safety glasses.

It is worth pursuing another aspect of eye safety programs. California (like many other states) has had school eye safety laws for about ten years. We never mention the law as the basis for our eye safety program but its requirements are always in the background. This type of law has surely had a marked influence on directing attention and action towards eye safety.

Along with this very positive effect has come the complications which always seem to accompany legal documents. In most states treated street glasses do not meet the school eye protection specifications. A rigidity in interpretation and implementation of the laws often results in school eye safety programs becoming an exercise in discipline rather than in safety common sense. Economies combined with the legal requirements can result in public school districts purchasing inexpensive plastic goggles. These meet the letter of the law but tend to be uncomfortable and often optically poor. Fogging is often serious. The students resist wearing such uncomfortable safety devices. It is true that blindness is much more uncomfortable - however our goal should be to develop a good safety attitude through an effective and reasonable safety program. I would challenge our safety engineers to develop eye protection devices that are effective, economical, and comfortable.

Economics is an important aspect of safety which students seldom consider. In the chemical industry economics plays a significant role in promoting safety programs. It is worth pointing out the economic implications of an injury and resultant loss of class time to a student. In a university operating under the quarter system (11-12 week class periods) an injury requiring absence from classes for 2-3 weeks will almost always necessitate the student dropping out of classes for the entire quarter period. This can end up delaying graduation for one quarter (three months) or more. In potential earning power (1974) the B.S. chemist loses about $2800. This very real but often unrealized result of an accident is quite revealing to students. The following best reflects this idea:

> "No safety device or procedure is a hindrance since nothing is as time consuming as an accident."

We have seen that an effective university program includes two approaches - action which involves providing a safe working environment and indoctrination, the educational part of the safety program. By now I hope that the original question presented (WHY SAFETY?) is no longer a question!

SAFETY PROBLEMS OF A FEDERAL AGENCY ON A UNIVERSITY CAMPUS

John S. Coogan
Safety Officer
National Research Center-Las Vegas

To begin with, I must comment on the title of this presentation. Safety Problems of a Federal Agency on a University Campus. That, I think, may mislead some of you to assume that Federal Agencies have a whole distinct set of safety problems. Nothing could be further from fact. Whether Federal Agency or private industry, we all have one set, and very nearly the same set, of safety problems. In fact, OSHA, a Federal Agency, has the authorization to apply the same rules to both government agency and private industry. The only difference is that, by law, OSHA cannot levy a monetary fine against another government agency.

It is the fact that OSHA pressed for legislation to have the safety rules apply to private industry as well as to government agencies that substantiates the theme that we all have generally the same set of safety problems. In saying this, of course, I realize that safety problems in your location may be far more unique than the oversimplication I have mentioned.

Robert Townsend, author of the book, "Up The Organization," lists three areas to be controlled in order to solve organizational problems: First - private secretaries; second - company automobiles; and third - keys to the building of the facility. Think about safety for a minute. If we could control people, machines and animals, would we have any safety problems? I am talking about positive control over people, animals and machinery.

While you are thinking about that, let me ask another question. How many of you attending this conference have a Federal installation on your campus? May I have a show of hands? Now, how many of you know the name of the safety officer at these installations? In the United States, each Federal Agency must have an individual designated as the safety officer. In smaller installations, each head of a facility shall assign collateral duty safety responsibility to a staff member. This can be a part-time function, but, the responsibilities and duties are all-inclusive for safety. My reason for asking these questions is that it is my belief that many of you do not know the federal safety officer presently on your campus, or, I suspect you are not thoroughly aware of precisely what work or research is performed at these facilities. That reflects one of the prime problems of the safety officer - poor communication. I really think we need to improve the channels of communications between the groups.

Largely, the safety problems on a federal facility located on a university campus are the same as the ones which you face in your everyday tasks. Let me enumerate a few of these for you to see if we don't agree:

Situation

1. No anti-siphoning devices on hot and cold water faucets. This can create the possibility of backflow into the potable water of the facility.

2. Flammables are not being stored in approved flammable storage cabinets, and while in use in the laboratory they are not kept in explosion proof containers.

3. Hazardous materials including radioactive chemicals and pesticides were being used at various locations throughout the facility. There was no posting of these areas to keep out unauthorized personnel or to advise what the hazard was. (i.e., it is illegal to expose anyone under 18 years of age to radiation in an occupational setting, and women in the 1st trimester of pregnancy should not be exposed to radiation needlessly.)

4. There were numerous areas on the facility that were cluttered with long and short-term storage items. There was no adequate protection for these areas and they do increase the fuel load in several locations.

5. Toxic materials were in use at numerous locations and while users had access to respirators there were no respirators strategically placed for rescuers use. No procedures existed for care and maintenance of respirators currently in use.

6. Chemicals were stored in hoods, under cabinets, on shelves and in other locations in a happenstance order. These problems sound familiar? I am sure they do. There are basically the safety problems which any laboratory is confronted with. Good housekeeping is the key to any safety program and this with the other items listed require constant attention.

And how do we resolve the situation? Let me read some recommendations for you to consider.

Recommendations

1. Install individual back flow preventers on each laboratory outlet to protect the facility's potable water supply.

2. Obtain approved flammable storage cabinets for each building and explosion-proof containers for use in each laboratory. Flammables should be placed in the storage cabinets when not in use, and at the end of each work day quantities in excess of that which can be stored in approved cabinets should be kept in the hazardous storage building.

3. Post areas identifying hazards and restricting access as appropriate. Establish written standard operating procedures for each hazardous chemical or substance used and familiarize everyone in the area with emergency procedures.

4. As soon as possible, construct an adequate storage building for the facility.

5. Obtain and strategically locate respirators to be used by potential rescuers. Procedures should be developed and training courses held to familiarize these potential rescuers with the equipment. A maintenance schedule and procedure should be developed for all respirators in use and should be strictly adhered to.

6. Obtain storage cabinets, or build adequate storage, and keep chemicals stored in an approved manner. I. E., separate reactive chemicals. Storage should be according to hazard. Sound familiar? I'll bet some of you have used some of the same platitudes or wording quite similar, in preparing reports on corrections at your facility.

My purpose of stating these situations and recommendations is to establish the fact that we have a common problem.

The Federal Agency, on a university campus, usually has a research facility of some nature and/or a laboratory in conjunction with its activities. The theme I wish to dwell upon is that neither the federal people nor the university people are completely aware of each other's safety problems. In many situations, such as the facility I have safety responsibility for, university students are used for part-time help, often as technicians in the laboratories. At our facility, many of these students have worked for the University in various laboratory positions as technicians prior to employment. The safety attitudes which they bring with them are usually excellent. It indicates to me that the professors and laboratory personnel they have worked for are aware of safety and striving to maintain a positive program. I am interested in these young people and their attitudes towards safety, because they are the researchers and laboratory directors of the future, and how they approach safety now is the way it will likely be conducted in the future.

Returning now to my earlier statement, that safety problems would disappear if we had control - positive control - over people, animals, and machines. But such control would give us very untenable work situations. Of course, if we had no safety problems, we would not have a job. But if any job is in jeopardy, it's not the safety man's. Safety problems, like unpredictable weather, are always with us. What is happening, though, is that today's work force, man for man, is better educated and more safety conscious than ever before. Nevertheless, personal injury suits are being filed more often and larger amounts of money awarded by the judicial system than ever before. In fact, it is not usual even in today's market of high unemployment to have prospective employees refuse to perform some job function because of alleged unsafe conditions or conditions injurious to their health.

All these factors point to one goal, that we cannot tolerate the expense of unsafe conditions which permit accidents to occur. We can't eliminate accidents entirely, but reduction of accidents thru control and a safe work place are a must. Our younger workers are no longer going to tolerate working conditions that are injurious to their health.

The safety problems a Federal Agency can be confronted with on a University Campus are really no different than those of other organizations. They may be more intense such as at our laboratory where worker age is lower than an average government installation due primarily to student help. Also, as I mentioned before, our work has a great variety of research and monitoring systems, employing a large and small animal facility, laboratories using radioactive material, pesticides, and air and water pollutants, a laser laboratory, an aerial group to collect samples, a greenhouse and associated growth chambers for plant experimentation. In addition, we have shops and craft people, warehousing, electronics technicians, and all the related services which make a facility run.

Most of the laboratory activities described are on a University Campus. The facilities which we occupy on the campus are surrounded by university buildings. We are centrally located rather than occupying an edge of the campus or an industrial research complex that some universities have.

Yet, still, our safety problems are routine, to the degree that back injury from lifting strain is still the number one personnel injury. We, however, do have materials which have to be controlled, such as pesticide concentration and radioactive isotopes - restricted areas such as laser facilities, cryogenic laboratories and so forth - and sensitive samples such as sample results which will be used as evidence in court actions.

Some of these problems present safety hazards which we have no control over. For example, standby power is not available in the case of primary power failure in risk areas. In some instances, we have not been notified of pending power outages. When these occur it presents the risk of losing an experiment or damaging delicate electronic equipment. Fire alarms in the buildings which are tied to the University System is another safety problem, especially with faulty and false alarms. Recently we have worked out with the University a separate system for our laboratories which alarms at the Fire Station.

As you can see, our safety problems are largely the same as yours, such as in biohazard areas. Have all personnel been instructed as to exactly what remedial action must be taken in case of a "spill," i.e., accidental release of pathogenic organisms or toxic materials? What provisions have been or will be made to cover the applicable requirements of the Williams-Steiger Occupational Safety and Health Act (OSHA) of 1970? Every safety problem has its questions that must be asked - and answered effectively.

But beyond this - that Federal Agency on your campus, are you aware what they do, what biohazard or toxic materials they use, what safety hazards they pose on your campus, what assistance you might provide or, alternatively, what assistance they might provide?

Are procedures in effect for the reporting and follow-up of accidents which affect both your campus and the Federal Agency? Remember that fellow on your campus would like to hear from you, and who knows, two heads are better than one in solving problems - particularly safety problems.

In closing, I have some slides to present. I gleaned them from our photo morgue. Please note any familiar safety deficiencies which you detect. Remember these are not posed photographs but rather photos someone took of his organization for posterity - or for reasons other than safety.

Photos showing

These photos, I think, are a good summary of what I've been saying--they show that safety problems aren't unique to any one area. If you haven't seen something here that typifies some of your own local safety problems, you're in a very untypical area of safety concerns.

THE SITUATIONAL APPROACH TO LOSS CONTROL

Hugh Douglas
Senior Coordinator
Accident Prevention and CYI
Imperial Oil Limited

There is a truism that people will only move if they recognize good or evil in the situation for them; and, it is practical and possible to do something about it.

Either the general public is not aware of the high and rising "accident" toll, they do not believe it is practical and possible to do anything about it or, they have a double standard of values. It is a do as I say, not a do as I do world. The point is well illustrated by a "Nancy" cartoon.

That there is a problem is confirmed by the facts that---"Every year in North America more than:

130,000 persons are fatally injured
500,000 incur permanent partial disability
15,000,000 are temporarily disabled
$40,000,000,000 is wasted

---because of incidents that are mistakenly called "accidents."

These facts confirm that "accidents" are a social and economic blight.

The numbers suggest five justifications for actions to preclude the unfortunate happenings. The justifications are:

. Self Preservation
. Moral Responsibility
. Economic Savings
. Resource Conservation
. Abiding by the Law

The justifications have always been present.

The results suggest past approaches have not been good enough. A better way must be developed. The inherent risks in each situation must be appraised and appropriate actions must be taken to ensure that untoward incidents are avoided or, if they do occur their adverse effects are minimized.

Traditional Approaches Have Failed

It is recognized that everyone filters all communications according to personal needs, values and experience. The statement that past approaches have failed may cause some to take exception to the statement that society has failed. The task at hand is to overcome the resistance any of you might have.

An attempt will be made to look at a new perspective using logic rather than emotional appeals.

The past and present method of accident prevention programming can largely be summarized as the "people" approach.

Three main thrusts are followed:

Motivate the people to be safe;
Train them to work safely; or
Get rid of them if they won't work safely.

Psychological studies confirm that while these thrusts may have good effect in the short run, they do not have long term success. They fail because people have the faculty to tune out noise. A continual barrage of emotional challenges to be safe becomes noise even though the messages offer personal advantages.

A better method must be found. The situational approach is suggested. It is based on logic rather than emotions. It also provides the opportunity to include emotional thrusts as a motivating stimulant.

The situational approach requires that all potential risks in each situation be evaluated in relation to economic objectives and social obligations and, appropriate action be taken.

The Cause Must Be Determined First To Prescribe The Best Cure

There is an adage in medical circles that the cause of the disease must be known before the corrective prescription should be prescribed.

The same principle applies in safety, accident prevention or loss control.

Two theories of cause have formed the base of most accident prevention activities to date. They are:

- Accidents are caused by errors.
- Accidents are the adverse result of unplanned, unexpected release of energy.

The first, and probably best known explanation of cause was developed by the late Henry Heinrich. He postulated that injury is the fifth in a series of five steps in the accident sequence. He made the concept visible and practical using dominoes. The concept is known as the "domino" theory.

The five steps of the domino sequence are:

1. The genetic and environment background of the individual.
2. The traits of the individual.
3. Unsafe acts and unsafe conditions.
4. The accident.
5. Injury.

Three principles were involved:

- The injury and accident were the undesirable end result of a sequence of events.

- An accident can occur without injury. But, an injury cannot occur without an accident.
- Removal of the unsafe acts and unsafe conditions eliminates the opportunity for an "accident" to occur.

While the concept is excellent, and very valid, an interpretation developed that has done much harm. Because those injured usually are directly involved in the "unsafe" acts and "unsafe" conditions, investigations tend to be fault-finding, blame fixing witch hunts.

The net result is that those involved automatically (and quite naturally) adopt a defensive posture. They only acknowledge those causal factors that would not incriminate them.

The early sixties saw a new error perspective. Because management created and provided the leadership, resources, organization and the total environment, if an incident occurs it is management's fault. Management did not provide a hazard-free environment. A new scapegoat was found.

A harmful result of the error concept is the creation of an adversary relationship between management and employees as to which was to blame for any incident.

The second concept of cause was that "accidents" are the result of unexpected, unplanned releases of atomic, chemical, electrical, mechanical, thermal, etc., energy. The advantage of this concept is it focuses on opportunities to provide appropriate action to either protect against untoward incidents or minimize their adverse effects should they occur.

A third concept is offered as a basis for more accurate diagnosis and to direct more effective preventive action. This one is not in the texts. In fact, it has never been formally presented to such a gathering. It has been introduced into Imperial's operations.

Three steps are involved in any "accident" sequence. They are:

- The immediate cause is the unplanned, unexpected release of enery.
- The unplanned, unexpected release of energy is released because the physical and procedural standards necessary for the completion of the situation without untoward incident were either not set; or, were not set high enough.
- Failure to set and/or meet adequate standards occurs because of deficiency in the fundamental ways an organization is administered.

Sight must not be lost of the fact that external technological, economic, social, political and legal influences have an important effect on the direction of the organization.

The three steps involve every part of the organization. Because everyone plays a part, in keeping with his or her level of authority, prevention/control becomes a "we" responsibility rather than a "you" responsibility. And, accountability must also be shared. It is hard to blame others if you share in the cause.

Examination for weakness/deficiency in each part of each step is necessary if effective preventive/corrective action is to be applied.

Unplanned, uncontrolled release of energy can be controlled/minimized following one or a combination of the following:

- Avoid the energy build-up.
- Reduce any build-up.
- Prevent uncontrollable release.
- Modify rate of release.
- Separate releases in time or space.
- Use barriers.
- Modify the surface.
- Strengthen the materials.
- Reduce adverse effects by appropriate contingent action.
- Rehabilitate.

The second step or proximate cause, the failure to set or meet adequate standards is critical. It relates to Heinrich's third domino--the unsafe acts, unsafe conditions. The difference is that setting adequate standards avoids unsafe acts and conditions. It is positive, whereas removing the unsafe acts and conditions is an after-the-fact activity.

Because of its importance in the sequence, the rationale of the concept is explained in detail. A series of sequential steps is involved. They are as follows:

- Anything that is done is done to fulfill a specific purpose, objective or goal.

- Accomplishment of the purpose, objective or goal requires the allocation of specific resources and activities.

- There is an upper and lower acceptable range of use required of resources beyond which it is too costly.

- If the upper range is exceeded, too many resources, or too high quality of resources or activities were used.

- Deviations below the lowest acceptable range result in inferior quality or use; and, under the right circumstances may result in some form of a downgrading incident.

- The nature of the downgrading incident is largely a matter of chance dictated by the environment and the manner of interface of the components at a given moment in time.

The effects of a downgrading incident are illustrated in attachment 1. Evaluation of potential effects and who they affect indicates the seriousness of the problem.

This information is necessary as a base for determining how much can, should, or must be spent on prevention/control.

The third step is referred to as the underlying causes. They are the organizational deficiencies that lead to or contribute to the failure to set and meet adequate standards. They fall in the following groups.

Deficiencies in:

Direction
Resources
Organization
Physical Environment
Administration
Continuous Functions

They are detailed in attachment 2.

There Is No Pushbutton Answer

There is no pushbutton answer in preventing/controlling untoward incidents.

Every decision required in the accomplishment of each purpose, objective or goal involves a trade-off between what is socially unacceptable and what is economically unacceptable.

The challenge to each person, in keeping with his or her level of authority, is to clearly define the upper and lower limits to ensure that the lower limit is set high enough that untoward incidents will not occur and to see that the lower limit is met. Deviations must be corrected before they lead to circumstances conducive to allowing an untoward incident to occur.

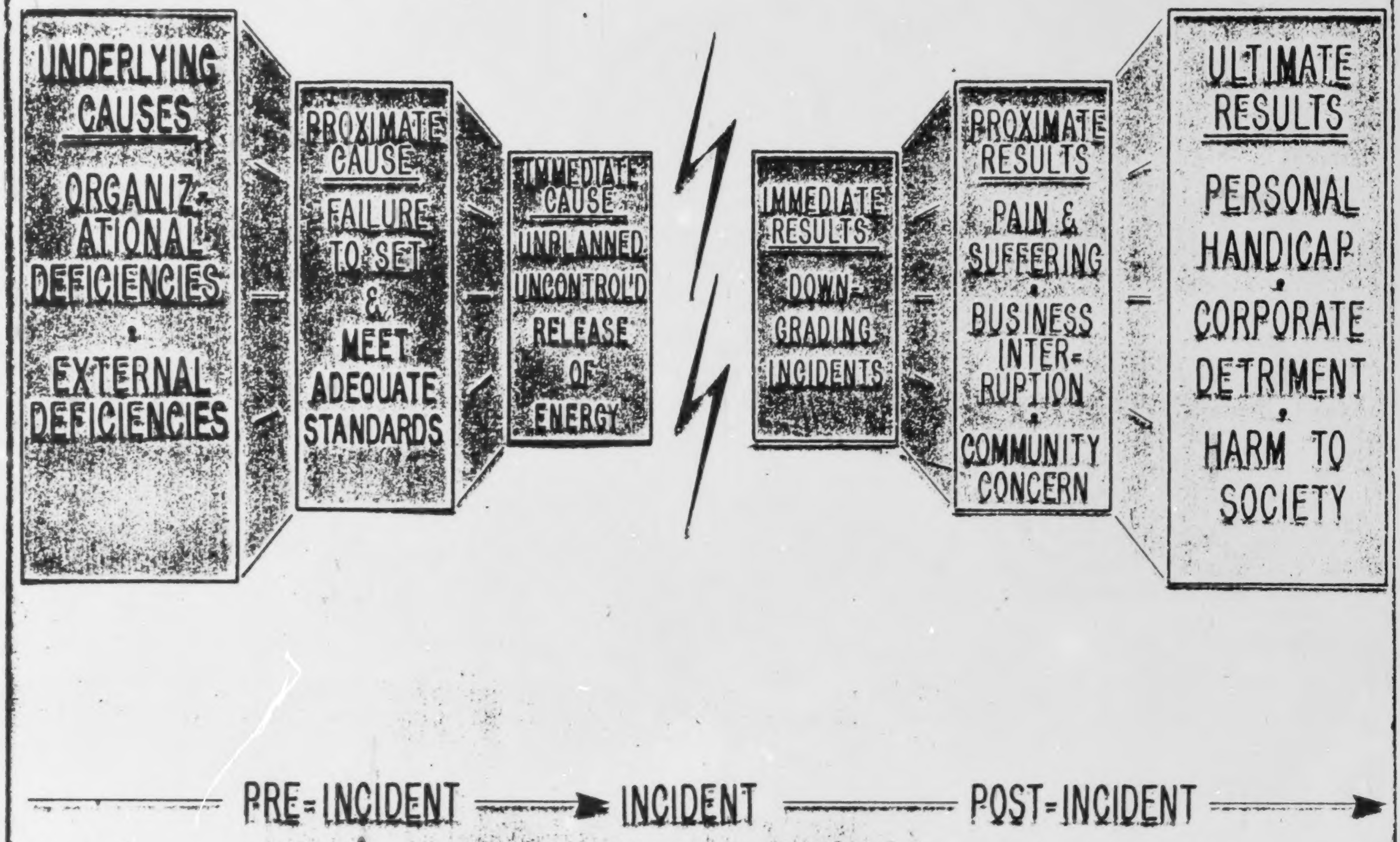
The concept has the following advantages. It is

. Positive.
. Preventive rather than after the fact.
. Logical rather than emotional.
. Situational rather than general.

And---it works!

RESOURCE MANAGEMENT

THE CAUSE & EFFECT SEQUENCE OF DOWNGRADING INCIDENTS



UNDERLYING CAUSES

ORGANIZATIONAL DEFICIENCIES
•
EXTERNAL DEFICIENCIES

PROXIMATE CAUSE

FAILURE TO SET & MEET ADEQUATE STANDARDS

IMMEDIATE CAUSE

UNPLANNED UNCONTROL'D RELEASE OF ENERGY

IMMEDIATE RESULTS

DOWNGRADING INCIDENTS

PROXIMATE RESULTS

PAIN & SUFFERING
•
BUSINESS INTERRUPTION
•
COMMUNITY CONCERN

ULTIMATE RESULTS

PERSONAL HANDICAP
•
CORPORATE DETRIMENT
•
HARM TO SOCIETY

PRE-INCIDENT → INCIDENT → POST-INCIDENT →

THE CAUSE AND EFFECT SEQUENCE OF DOWNGRADING INCIDENTS

A. THE CAUSE SEQUENCE

Underlying Causes

Organization Factors
- Direction
  - Actions
    - Objectives
    - Policies
    - Example
    - Thrusts
    - Constraints
  - Philosophy
    - Concepts
    - Values

- Resources
  - People
  - Ideas/Technology
  - Time
  - Money
  - Materials
  - Energy

- Organization
  - Formal
  - Informal

- Standards
  - Legal
  - Consensus
  - Practices
  - Procedures

- Tasks/Technology
  - Processes
  - Equipment

- Administration
  - Selecting
  - Planning
  - Organizing
  - Implementing
  - Controlling

- Continuous Functions
  - Communication
  - Motivation
  - Training
  - Responsibility
  - Authority
  - Accountability

External Factors
- Technological
- Economic
- Social
- Political
- Legal

THE CAUSE AND EFFECT SEQUENCE OF DOWNGRADING INCIDENTS

THE PROXIMATE CAUSE

Personal Deficiency

- Physical;
- Mental;
- Attitudinal,

Resulting in Lack of

- Knowledge;
- Skill; and,
- Judgement

Resulting in Failure to Set and/or Meet Adequate Standards:

- Equipment
  - Design,
  - Construction,
  - Operation,
  - Maintenance.
- Processes/Procedures/Practices
  - Detail,
  - Communication,
  - Application.

IMMEDIATE CAUSE

The Unplanned, Uncontrolled Release of:

- Atomic;
- Chemical;
- Electrical;
- Mechanical;
- Thermal;

energy.

THE CAUSE AND EFFECT SEQUENCE OF DOWNGRADING INCIDENTS

B. THE EFFECT SEQUENCE

Downgrading Incidents

- Injury/Illness
  - Fatality
  - Disability
    - Permanent Total
    - Permanent Partial
    - Temporary Total
  - Medical Aid
  - First Aid
- Fire/Explosion
  - Injury/Illness
  - Equipment Damage
  - Product Damage/Loss
  - Production Stoppage
- Damage
  - Equipment
  - Facilities
  - Property
  - Supplies
  - Tools
  - Vehicles
- Product
  - Degradation
  - Loss
- Pollution
  - Air
  - Ground
  - Water
- Breach of Security
  - Theft
  - Defalcation
  - Arson
  - Sabotage
- Work Slowdown/Stoppage
  - People
  - Equipment
- Energy Waste
  - Steam
  - Hydro
  - Water
  - Air

THE CAUSE AND EFFECT SEQUENCE OF DOWNGRADING INCIDENTS

IMMEDIATE RESULTS

Personal

- Pain
- Suffering
- Grief
- Physical/Mental Limitations

Business Interruption

- Physical Damage
  - Equipment
  - Facilities
  - Property
  - Supplies
  - Vehicles
- Product Abuse
  - Degradation
  - Loss
- Work Stoppage
- Service Delay/Failure
- Contamination
  - Air
  - Ground
  - Water
- Breach of Security
  - Abduction
  - Defalcation
  - Extortion
  - Theft

Community Concern

- People
- Environment
- Contingency Response
- Inconvenience

THE ULTIMATE RESULTS

Personal Handicap

- Physical
- Mental
- Economic
- Social

Corporate Detriment

- Economic Loss
  - Direct
    - Costs for
      - Repair
      - Rework
      - Substitution
      - Replacement
      - Legal

THE CAUSE AND EFFECT OF DOWNGRADING INCIDENTS

THE ULTIMATE RESULTS (CONT'D.)

- Increased Labour Costs
    - Contingent Response
    - Rehabilitation
    - Reduced Throughput

- Energy Waste
    - Air
    - Electrical
    - Steam
    - Water

- Indirect
    - Labour
        - Retraining
        - Lower Quality
        - More Required

    - Production
        - Reduced Quantity/Quality
        - Delayed
        - Alternate Supplies

    - Sales
        - Customer/Alienation Defection
        - Market Penetration Loss

Social Disfavour - (Default of socio-legal obligations)

- People
- Environment

Societal Loss/Interference

- Economic Shortfall
    - Material Shortage
    - Inflation
    - Inadequate Capacity
    - Soaring Demand
    - Delayed Delivery
    - Short Money Supply

- Resource Waste
    - Energy
    - Materials
    - Money
    - People
    - Technology
    - Time

Evaluation of Loss Control Results and Activities

- Assessment of the effectiveness of loss control activities is an essential part of measuring total performance.
- Net performance is the difference between the planned cost of reaching economic objectives and the losses experienced in attempting to reach them.
- Losses are the adverse consequences of the trade-off between risk and the primary functions of the company to meet its economic objectives and fulfill its socio-economic obligations.

An evaluation form is attached to permit an assessment of loss control results and efforts.

It is divided into seven parts.

- A summary of the type, number and cost of downgrading incidents.
- An overview assessment of the units in terms of:-
    - Orderliness;
    - Quality of work practices;
    - Hazard control; and
    - Contingency responses.
- Assessment of quality of loss control activities.
- Summary of interviews with personnel at all levels to determine thrusts for work effectiveness and constraints to work effectiveness.
- Response to special problem situations.
- Cost of loss control activities
- Recommendations.

The evaluation permits an assessment of the extent of unnecessary loss and the effectiveness of the control efforts applied to keep the losses to an acceptable level.

Completion of the chart will suggest what additional effort is required and how it should be applied.

Att.

EVALUATION OF LOSS CONTROL RESULTS AND ACTIONS

UNIT ______________________ DATE ______________ COMPLETED BY: ________________

LOSS EXPERIENCE

Type of Incident	Number of Incidents	Days Lost	Cost W.C.B. Injury - Payments	Company Make-Up	Total	W.C.B. Assessment
1. Injury/Illness On-the-job						
Fatality						
Permanent Partial						
Temporary Disabling						
Medical Aid						
First Aid						
Totals						
			Accident/Sickness Benefits			
Off-the-job injury/ Environmental illness						

2. Damage to:		Cost of:	Repairs	Replacements	Business Interruption	Total
Tools						
Equipment						
Vehicles						
Facilities						
Property						

3. Product Degradation		Cost of:	Rework	Replacements	Business Interruption	Total
Damage						
Loss						
Spill						
Mix						

		Cost of:	Extinguishment	Damage	Business Inter.	Total
4. Fire/Explosion						

5. Breaches of Security		Cost of:	Damage	Replacement	Business Interruption	Total
Theft						
Vandalism						
Defalcation						
Bomb Threats						
Arson						

		Cost of:	Product Loss	Clean Up	Liability	Total
6. Pollution						

		Cost of:	Hydro	Steam	Air	Total
7. Energy Waste						

8. **Totals**						

B. LOSS CONTROL ADMINISTRATION

1. DIRECTION

A. OBJECTIVES

- LIMITS OF PERMISSIBLE LOSS ARE SET ☐ NOT SET ☐
- THE LIMITS ARE HIGH ☐ LOW ☐ ZERO ☐

B. POLICY

- THERE IS ☐ IS NOT ☐ A STATED LOSS CONTROL POLICY
- IT IS WRITTEN ☐ VERBAL ☐ "JUST GROWED" ☐
- IT IS CONFINED TO INJURY/ILLNESS ☐ COVERS ALL FORMS OF LOSS ☐
- IT IS COMMUNICATED RARELY ☐ OFTEN ☐ CONSTANTLY ☐
- IT IS REJECTED ☐ ACCEPTED ☐ LITTLE ☐ WELL ☐

C. LEADERSHIP/EXAMPLE

- QUALITY: WEAK ☐ AVERAGE ☐ STRONG ☐
- FREQUENCY: SELDOM ☐ FREQUENT ☐ CONSTANT ☐
- STYLE: LOW PROFILE ☐ FRONT AND CENTRE ☐

D. VALUES

. LOSS CONTROL CONSIDERED BY:	MANAGEMENT	SUPERVISION	EMPLOYEES
PRIMARY RESPONSIBILITY			
SECONDARY RESPONSIBILITY			
NOT A RESPONSIBILITY			

- CONCERN FOR PEOPLE IS: LOW ☐ HIGH ☐
- EMPHASIS IS ON: RESULTS ☐ ACTIVITIES ☐
- DESIRE FOR EXCELLENCE IS LOW ☐ SO-SO ☐ STRONG ☐

2. RESOURCES

. AVAILABILITY	NOT ENOUGH	BARELY ENOUGH	SUFFICIENT	AVAILABLE AS REQUIRED
PEOPLE				
IDEAS				
MONEY				
TIME				
MATERIALS				

. QUALITY	INADEQUATE	GENERALLY ADEQUATE	ADEQUATE	EXCELLENT
PEOPLE				
IDEAS				
MATERIALS				

3. ORGANIZATION

. FORMAL	INADEQUATE	FAIR	GOOD	EXCELLENT
. REPORTING RELATIONSHIPS				

- COMMITTEE STRUCTURE
  - PRESENCE NONE ☐ SOME ☐ COMPREHENSIVE ☐
  - QUALITY POOR ☐ FAIR ☐ GOOD ☐ EXCELLENT ☐

- INFORMAL
  - STRENGTH WEAK ☐ STRONG ☐
  - SCOPE LIMITED ☐ NARROW ☐ BROAD ☐

4. STANDARDS OF TECHNOLOGY/TASKS

		SELDOM	SOMETIMES	GENERALLY	ALWAYS
. AVAILABILITY	DESIGN	☐	☐	☐	☐
	CONSTRUCTION	☐	☐	☐	☐
	OPERATION	☐	☐	☐	☐
	MAINTENANCE	☐	☐	☐	☐

		INADEQUATE	LOW	ADEQUATE	HIGH
. QUALITY	DESIGN	☐	☐	☐	☐
	CONSTRUCTION	☐	☐	☐	☐
	OPERATION	☐	☐	☐	☐
	MAINTENANCE	☐	☐	☐	☐

		SELDOM	SOMETIMES	GENERALLY	ALWAYS
. APPLICATION	DESIGN	☐	☐	☐	☐
	CONSTRUCTION	☐	☐	☐	☐
	OPERATION	☐	☐	☐	☐
	MAINTENANCE	☐	☐	☐	☐

5. ADMINISTRATION & SUPERVISION

TASKS ARE PLANNED	SELDOM ☐	SOMETIMES ☐	ALWAYS ☐
TASKS ARE ORGANIZED	POORLY ☐	ADEQUATELY ☐	WELL ☐
TASKS ARE CONTROLLED	LOOSELY ☐	TIGHTLY ☐	FIRMLY ☐

C. SPECIFIC LOSS CONTROL ACTIVITIES

. INSPECTIONS	NO	YES			
		OCCASIONAL	REGULAR	OCCASIONAL	REGULAR
SR. MANAGEMENT	☐				
LINE					
. JOB	☐				
. CRITICAL PARTS	☐				
. PERSON					
.ANNOUNCED	☐				
.UNANNOUNCED	☐				
COMMITTEE					
.MANAGEMENT	☐				
.JOINT	☐				
.AD HOC	☐				
STAFF	☐				
OUTSIDE	☐				

. INVESTIGATIONS		EXTENT		QUALITY		FOLLOW UP	
		Some	All	Superficial	Thorough	Yes	No
. INJURY/ILLNESS	☐	☐	☐	☐	☐	☐	☐
. FIRE/EXPLOSION	☐	☐	☐	☐	☐	☐	☐
. DAMAGE	☐	☐	☐	☐	☐	☐	☐
. PRODUCT							
LOSS	☐	☐	☐	☐	☐	☐	☐
DEGRADATION	☐	☐	☐	☐	☐	☐	☐
. POLLUTION	☐	☐	☐	☐	☐	☐	☐
. BREACH OF SECURITY	☐	☐	☐	☐	☐	☐	☐
. ENERGY							
LOSS	☐	☐	☐	☐	☐	☐	☐
WASTE	☐	☐	☐	☐	☐	☐	☐
. OTHER	☐	☐	☐	☐	☐	☐	☐

C. SPECIFIC LOSS CONTROL ACTIVITIES (CONT'D.)

. JOB ANALYSES

EXTENT: NONE ☐ SOME ☐ SPECIAL ☐ ALL ☐

QUALITY: POOR ☐ FAIR ☐ GOOD ☐ EXCELLENT ☐

DETAIL: LITTLE ☐ SOME ☐ MUCH ☐ VERY ☐

CURRENT: OUT OF DATE ☐ CURRENT ☐

. EMPLOYEE CONTACTS MADE YES ☐ NO ☐

IF YES:	PLANNED ☐	UNPLANNED ☐
. FREQUENCY	NONE ☐ SELDOM ☐ FREQUENTLY ☐	NONE ☐ SELDOM ☐ FREQUENTLY ☐
. SCOPE	GENERAL ☐ JOB ORIENTED ☐	GENERAL ☐ JOB ORIENTED ☐

. INCIDENT	EXTENT			QUALITY			
	NONE	SOME	ALL	POOR	FAIR	GOOD	EXCELLENT
REPORTING	☐	☐	☐	☐	☐	☐	☐
RECORDING	☐	☐	☐	☐	☐	☐	☐
ANALYZING	☐	☐	☐	☐	☐	☐	☐

. CONTINGENCY PLANS DRAWN UP:

FIRST AID ☐
FIRE CONTROL ☐ EXTINGUISHMENT
OIL SPILL ☐
PRODUCT MIX ☐
POLLUTION ☐
ENERGY WASTE OR LOSS ☐
BREACH OF SECURITY ☐
MUTUAL AID ☐

. TRAINING			QUALITY		
TYPE	YES	NO	INADEQUATE	ADEQUATE	EXCELLENT
INDUCTION	☐	☐	☐	☐	☐
JOB	☐	☐	☐	☐	☐
FIRST AID	☐	☐	☐	☐	☐
FIRE RESPONSE	☐	☐	☐	☐	☐
HAZARD RECOGNITION	☐	☐	☐	☐	☐
PROTECTIVE EQUIPMENT	☐	☐	☐	☐	☐
PROCEDURES					
WORK PERMITS	☐	☐	☐	☐	☐
GAS TESTING	☐	☐	☐	☐	☐
VESSEL ENTRY	☐	☐	☐	☐	☐
HOT TAPS	☐	☐	☐	☐	☐
DRY RUNS	☐	☐	☐	☐	☐
GENERAL	☐	☐	☐	☐	☐

. LOSS CONTROL PROMOTIONS -- ON-THE-JOB

. MEETINGS	NONE	PERIODICALLY	REGULARLY
PLANT	☐	☐	☐
FUNCTION	☐	☐	☐
TRADE/UNIT	☐	☐	☐
CROSS FUNCTIONS	☐	☐	☐
FIVE-MINUTE TALKS	☐	☐	☐

C. SPECIFIC LOSS CONTROL ACTIVITIES (CONT'D.)

USE OF:	YES	NO
AUDIO VISUALS	☐	☐
POSTERS	☐	☐
PERSONAL CONTACTS	☐	☐
INCIDENT RECALL	☐	☐
PROMOTIONAL ITEMS	☐	☐
DINNERS	☐	☐
SPECIAL PROGRAMS		
E.G. KNOWING'S NOT ENOUGH	☐	☐
SAFETY SAM	☐	☐
HAND TRAP TEST	☐	☐
DEFENSIVE DRIVING	☐	☐
SEMINARS	☐	☐

LOSS CONTROL PROMOTIONS -- OFF-THE-JOB

	YES	NO
POSTERS	☐	☐
LETTERS	☐	☐
PHONE CALLS	☐	☐
CONTESTS	☐	☐
SLOGANS	☐	☐
FLYERS	☐	☐
DEFENSIVE DRIVING	☐	☐
FIRST AID TRAINING	☐	☐
PLANT VISITS	☐	☐

D. COSTS OF LOSS CONTROL ACTIVITIES

	$
TIME	☐
MATERIALS	☐
PERSONAL PROTECTIVE EQUIPMENT	☐
OPERATING EXPENSE	☐
CAPITAL EXPENSE	☐
CONTINGENCY PLANS	
. EQUIPMENT	☐
. MANNING	☐
. TRAINING	☐
LEGISLATED REQUIREMENTS	☐

E. INTERVIEWS

MANAGEMENT'S VIEW OF STATUS OF LOSS CONTROL

THRUSTS	CONSTRAINTS
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COMMENTS

FIRST LINE SUPERVISION'S VIEW OF STATUS OF LOSS CONTROL

THRUSTS	CONSTRAINTS
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COMMENTS

VIEW OF OCCUPATIONAL PERSONNEL REGARDING SAFETY & ACCIDENT PREVENTION

THRUSTS	CONSTRAINTS
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COMMENTS

F. SPECIAL PROBLEM AREAS

- OBTAINING COMPLIANCE WITH STANDARDS, PRACTICES AND RULES
- MAINTAINING ORDER
- PROPER USE OF TOOLS AND EQUIPMENT
- GETTING HIGH LEVEL OF PERFORMANCE IN FACE OF HIGH LABOUR TURN OVER
- GETTING EMPLOYEES TO WEAR PROTECTIVE EQUIPMENT AS REQUIRED
- EFFECTIVE USE OF EMPLOYEES HAVING PHYSICAL/MENTAL DIFFICULTIES
- FATIGUE
- ABSENTEEISM
  - (1) ILLNESSES
  - (2) ALCOHOL
  - (3) DRUG

RECOMMENDATIONS

DIRECTION

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RESOURCES

. PEOPLE
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. TIME
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  .

. MONEY
  .
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  .

ORGANIZATION

. RESPONSIBILITY	ADEQUATELY DELEGATED	WITHHELD
. SENIOR MANAGEMENT		
. FIRST LINE SUPERVISION		
. OCCUPATIONAL		

. AUTHORITY	GRANTED		WITHHELD
	Partial	Full	
. SENIOR MANAGEMENT	☐	☐	☐
. FIRST LINE SUPERVISION	☐	☐	☐
. OCCUPATIONAL	☐	☐	☐

. ACCOUNTABILITY	EXERCISED	WAIVED
. SENIOR MANAGEMENT		
. FIRST LINE SUPERVISION		
. OCCUPATIONAL		

RECOMMENDATIONS (CONT'D.)

MOTIVATION

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COMMUNICATIONS

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TRAINING

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MEASUREMENT/AUDITS/ACCOUNTABILITY

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CONTINGENCY ACTIONS

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PORTABLE COMBUSTIBLE & TOXIC GAS INDICATORS & ALARMS

M. F. Melette
Midwest District Manager
Bacharach Instrument Company

The basic portable Combustible Gas Indicators available today are the product of nearly 50 years of manufacturing and safety application experience.

The original Combustible Gas Indicator was developed in 1927 to fill the requirements of the Petroleum and Chemical industries. The principal requirement was to measure the presence of all hydrocarbons in concentrations well below their Lower Explosive Limit (L.E.L.).

Combustible Gas Indicators manufactured today are considerably more sophisticated than the original portable instrument. As an example, some models currently manufactured can measure gases in three ranges. Other instruments offered measure two parameters -- oxygen level and the presence of combustible gases.

The most common instrument in use today is a single range Combustible Gas Indicator that uses an aspirator to draw the sample under test into the instrument via an external sampling hose and probe. The usage of the sampling hose and probe allows the testing of manholes, vaults and tanks for combustible condition prior to entry by maintenance personnel. Also available are instruments that will measure two important variables simultaneously -- oxygen level and the presence of combustible gases.

For those applications that may require monitoring of a specific work area during plant maintenance, portable instruments are now available that will provide an audible alarm if the atmospheric conditions change. It is not necessary for the worker to periodically operate the instrument and observe the meter indication. A typical application would be welding operations in Chemical and Petroleum plants. Diffusion sampling is the most common method of detection used for this application. (The portable instrument is placed in the general work area where flammable gas or vapors may be released.)

In addition to the portable instruments that I have just described, there are many special instruments that measure in the PPM range of toxic hydrocarbons.

Pitfalls and Limitations

To obtain meaningful and reliable readings from any portable gas indicator the following instrument conditions must be satisfied.

Portable instruments must have adequate battery power reserve to provide excitation voltage to properly heat the catalytic sensor (filament or element). Low battery voltage could cause serious errors in the instrument readings.

It's recommended at the start of each test that the zero control knob and voltage control should be adjusted up and down scale to confirm smooth operation by observing meter deflection. This also proves that the indicator meter is operational.

The calibration of the basic instrument should be challenged on a regular schedule. Calibration test gas samples are available in various containers that may be conveniently used to confirm the instrument calibration. This will guard against the problem of the sensor becoming poisoned by substances such as leaded gasoline or silicone vapors.

The internal flame arrestor should be inspected at regular intervals to prove that the sample flow passes over the internal catalytic filament at a flow rate not less than 472 CC per minute. If excessive quantities of contaminates (dust, water) clog the flame arrestor, the flow rate can be seriously reduced.

The remote probe and hose components used to draw the atmosphere under test into the portable instrument are also a vital link in this measuring system. If any leaks are present at any of the interconnect fittings that join the probe, hose and instrument, the dilution by ambient air could cause error in the indicator reading.

The aspirator bulb or pump device used to draw the sample into the instrument should be examined for leaks at scheduled intervals. Leakage of the aspirator bulb or the check valves could result in errors. The minimum acceptable sample flow rate is 472 CC per minute or 1 CFH.

The actual scheduling of the above component tests will vary based upon how rigorously the instrument is used. Example: daily use by utility crew vs. occasional test in a research laboratory.

Certain tests such as battery condition, hose and probe condition and meter deflection must be made daily. Frequency of the calibration check and other components inspection are a decision that should be made by individual safety departments based upon their specific plant conditions.

The principal limitation to these instruments is that they measure only combustibles in air. If two or more hydrocarbons in air are present, these instruments will not provide the individual value of each gas present, but the sum of all as a meter indication.

The interpretation of the indicator meter deflection is also a judgment factor that must be considered by individual safety departments.

GAS DETECTION ON CAMPUS

Warren J. Riley
Director of Training
Bacharach Instrument Co.

SUMMARY

The purpose of portable or continuous gas detection equipment is to provide a method for monitoring a condition which could result in a fire, explosion, or toxic atmosphere.

Gas detection techniques have evolved from rather primitive methods such as a canary in a cage or a lighted candle, to modern electronic instruments capable of detecting minute combustible and toxic gas conditions.

While some types of equipment can be misused with little or no long range effects, the wrong choice of a gas detector or its improper use or maintenance can result in death, injury, and major property damage.

In a comprehensive campus safety program it is not enough to merely be aware of a potentially toxic or combustible condition. It is now necessary to purchase, install, and continually maintain the equipment and insure that all affected personnel are routinely trained in its use. The proper equipment must be chosen, operators educated, and a regular schedule of maintenance and calibration strictly adhered to.

LEGAL AND MORAL ASPECTS OF GAS DETECTION EQUIPMENT

Changes in the law regarding safety have contributed to the growing use of combustible and toxic gas detectors. Some users, unfortunately, comply with the letter of the law, if not its intent, by purchasing one or more detector units and then ignoring them. For any toxic or combustible gas detector to be effective the user must understand its principles and its limitations. He must also be trained in the proper installation, maintenance, and operation of the equipment.

In the case of a major accident where life is lost or serious injury is sustained, there is almost certainly a substantial investment in time and money due to legal action. The outcome of such law suits can also include jail sentences for those deemed negligent.

In years past, death, injury or property damage due to negligence or misapplication could be discounted with a shrug of the shoulder. Today this is certainly not the case. The legal and moral ramifications of providing and maintaining proper safety equipment are obvious.

It is encumbent on each of us to insure that our involvement in establishing and maintaining good safety programs is founded on the use of prudent and reasonable actions.

THE DEVELOPMENT OF PRESENT DAY TECHNIQUES OF DETECTION

Modern day methods of electronic gas detection began almost 50 years ago with the commercial production of the Catalytic Combustion Detector. Since that time other techniques have been used in gas detection, such as thermal conductivity, electro-chemistry, optics, and chemi-physics.

CATALYTIC COMBUSTION - remains the most commonly used method of combustible gas detection.

THERMAL CONDUCTIVITY - used in the detection of inert gases.

ELECTRO-CHEMISTRY - used extensively for oxygen detection.

OPTICS - used for mercury vapor detection and in other low level gas detection systems.

CHEMI-PHYSICS (metal oxide sensor) - used in the detection of a number of toxic gases.

Catalytic Detection Systems use two elements arranged in a wheatstone bridge configuration. One element is a reference, the other is the active element. Elements are usually made of pure platinum wire. The platinum wire is coiled in the form of a filament or encased in a treated ceramic bead. As a mixture of combustible gas and air passes over the active element, catalytic combustion takes place. Oxidation on the surface of the heated element increases its temperature and thus its resistance. This change in resistance causes an imbalance in the bridge circuit which is read as a change in level of combustible gas. This same general technique can be adapted to low levels of detection where, through increased sensitivity of the sensor and the electronics, concentrations of combustibles in the two or three part per million range can be detected.

Electro-chemistry is the process whereby two electrodes are immersed in a solution. When the solution is exposed to oxygen an electric current flows from one electrode to the other. Thus the output of the electrochemical cell or "battery" is proportional to the oxygen content of the sample gas. This provides a simple and dependable method for measurement of varying concentrations of oxygen.

Optics is used in one form for mercury vapor detection, by transmitting a band of light through a sample chamber, an optical filter, and then to a receiving element. As the mercury vapor content of the air in the sample chamber varies, more or less light from the ultra-violet source is absorbed by the mercury concentration. A varying output from the receiving element is an indication of the concentration of mercury in the sample. This system is capable of detecting very low concentrations such as .05 milligrams per cubic meter.

Chemi-physics utilizes the conductivity capabilities of certain metal oxides. When these oxides are exposed to various gases or vapors their ability to conduct is changed due to an oxidation reduction process. This change in conductivity is noted as a change due to the specific gases being detected.

ACCURACY VS RELIABILITY

The toxic and combustible levels of various substances are usually determined in laboratory tests under laboratory conditions. The results, therefore, are of a rather static nature. In real life situations, the L.E.L. levels may be different from those stated in the reference books.

"Standard Gases" used in the calibration of toxic and combustible monitors are of varied accuracies and present additional problems in trying to establish absolute levels. Factors such as true zero may also be very difficult to determine. There are inherent variations due to tolerance build-ups in instrument components, and detectors, which add to deviations from absolute. For these reasons, a gas detector is generally designed to provide a degree of safety which will compensate for slight inaccuracies.

An excerpt from a paper given to the Maritime Section of the National Safety Council gives an interesting example of one users view of accuracy.

> "From a practical standpoint, a percentage of error in the reading means very little...An error in the explosive range is of no importance; for once you know you are in the explosive range, that is all you need to know. The sale of gas indicators is competitive and has led to a good deal of wrongly placed emphasis on accuracy and versatility. The tanker mate at sea doesn't need interpretation curves for gases he never heard of and will never need in practice... What we need is a simple, rugged instrument and training in its use."

Many users have adopted the philosophy that any indication of a combustible or toxic gas represents an unacceptable situation. Detectors used in this fashion could be considered go-no-go devices.

Repeatability and dependability in a gas detection instrument are more important than absolute accuracy. Gas detectors must operate in constantly changing environments and a detector which can "sniff out" a combustible or toxic gas condition under varying temperatures and pressures is far more valuable than an instrument which is accurate but limited in its operating use. In safety instrumentation repeatability, dependability and accuracy should be mutual goals.

LIMITATIONS OF GAS DETECTORS

When selecting or installing gas detectors a number of factors must be taken into consideration. These include:

- Select a detector which is limited to the general category of gases or vapors of interest.

- In many detection situations oxygen is necessary for the detector to function properly. In low oxygen concentrations (below 21%) certain detection methods give inaccurate readings or no reading at all even though a potentially dangerous condition may exist.

- Output of most gas detectors can be effective by a change in the line or power supply voltage. Depending on the type of detector, the change may materially affect the reading and this can contribute to a hazardous condition.

- Certain elements can be affected by various types of "poisons." These substances are usually ones which chemically or mechanically coat the sensor and render it "blind" to the condition it is supposed to sense.

- Detectors can only "sniff" the gas or vapor condition which contacts the surface of the sensor itself. Although this concept is obvious, it is one of the most often overlooked and underrated problems. The sensor cannot see a hazardous condition and it cannot hear a hazardous condition. It can only "sniff" the condition and thus a potentially hazardous situation in an area remote from the sensor may never be detected. For this reason proper placement or location of the detecting point must be carefully chosen so that it is representative of the atmosphere in question.

- General ambient conditions which may affect the detection process include movement of air by wind or forced ventilation, abnormal changes in temperature or humidity, and certain process factors.

- The performance of any gas detection system is only as good as the training and the conscientious attitude of the people who must use and maintain it.

MAINTENANCE

As with any safety device, the degree of dependability of a gas detector is directly proportional to the care it receives. All detectors require routine maintenance which includes voltage check, general unit performance checks, and regular calibration.

One of the most dangerous effects on employee morale is a series of false alarms generated by incorrectly installed or malfunctioning detectors. Employees begin to distrust the equipment and this leads to a feeling of indifference. All gas detectors should be given a regular go-no-go test, perhaps once a shift or once a week to determine if the device is functioning. This can be accomplished by applying a gross sample of the type of gas to be detected and watching the instrument for an indication. Calibration includes applying a known concentration of gas and adjusting the device for a resultant indication. Calibration should be performed at routine intervals perhaps once a quarter. The actual period of time between checks and calibration is usually a function of the confidence level of the operator.

TRAINING

The best equipment is no better than the ability of the operator using it. Without thorough, comprehensive training an operator cannot be expected to safely operate and depend on this equipment. Improper or incomplete training can lead an operator into a false sense of security which could cost him his life.

Some manufacturers of gas detection equipment realize the importance of training and offer training programs. The user should insist on this type of support from his supplier. If it is not readily available, he should consider another supplier.

LOGGING

In the event of a lawsuit resulting from an accident, evidence of proper training and maintenance may act as proof of good intention on the part of the employer.

Proper logging procedures also help to emphasize the importance of the entire program to the operator and his supervisor.

CONCLUSION

While most gas detection instrumentation is sound in design and function it can in no way replace the ultimate knowledge and decision making capabilities of a well trained operator. Except in cases where a control function is provided this equipment will not in itself "protect" a worker. Its sole function is to monitor a situation and inform responsible personnel of a potential hazard. Interpretation of warnings given by detection equipment must be left in the hands of a responsible individual.

GLOSSARY OF TERMS

There are a number of terms used in gas detection that are rather specific and often misunderstood. The following terms are defined as they apply to the specific field of gas detection.

L.E.L.	Lower Explosive Limit
U.E.L.	Upper Explosive Limit
T.L.V.	Threshold Limit Value
Poisoning	chemical or mechanical coating of the sensor which renders it "Blind" to the condition to be sensed.
System	a group of detecting components working together to provide continuous monitoring.
Calibration	adjusting of voltage and applying a gas of known concentration with adjustments as required.
Check	applying a gross sample of gas, noting general performance of the entire unit including alarms, lights, meter (recorder if attached).
P.P.M.	Parts Per Million - one or more parts of a substance in a million parts of background. (1% = 10,000 P.P.M.)

MINUTES

CAMPUS SAFETY ASSOCIATION
ANNUAL BUSINESS MEETING
August 6, 1975

The meeting was called to order at 1:35 p.m., by the Chairman, William H. Watson.

Excerpts from the minutes of the prior meeting were read by the Corresponding Secretary, Ray Hall. They reflected that Edward Simpson has lined up conference sites through 1980. Therefore, the next selection will begin in the year 1981. They also contained minor changes in guidelines made by the Awards Committee. In addition good reasons were stated for the Treasurer to hold office for three (3) years such as it gives continuity and coordination of funding during transition. They also mentioned that CSA is gaining in support by expanded contacts and that their sphere of influence is spreading rapidly. On motion the minutes were approved and accepted.

James N. Knocke, Treasurer, had to leave early, therefore, the Treasurer's report was read by Ray Hall. It reflected a cash balance as of May 31, 1975, of $1,139.94. Although CSA is slightly losing ground financially it still remains solid and viable. On motion the Treasurer's report was approved and accepted.

The Membership Committee, Chairman, William Steinmetz, reported that 96 new members were added to the roll during the year. In an effort to purge the roll of inactive or non-participating members 1213 cards have been mailed to various Colleges and Universities requesting that all memberships be brought up to date. So far there has been a 50-60% response.

The Awards & Recognitions Chairman, Ray Ketchmark is setting up guidelines and functions of the Awards Committee. During general discussion, the consensus of opinion was that future Awards should be framed or mounted to improve the image of CSA.

Pat Eaker, Wisconsin, had the primary responsibility for revision of CSA's Publications. He could not be present, therefore, Chairman Watson reported that he has been in contact with Pat and he has started updating and deleting all unnecessary CSA publications to help our budget. Pat will present his finalized report in September 1975, at the National Safety Congress in Chicago.

Richard W. Giles, Chairman, Fire Safety Committee, reported that their fire reporting questionnaires have been revised and are still coming in, but more are needed.

John Short, Site Chairman, Mississippi, has approved conference sites as follows: Orono, Maine-1976, Hawaii-1977, University of Illinois (Urbana Campus)-1978 (this is the 25th Anniversary of CSA and was founded there). University of Michigan-1979, University of Auburn-1980.

Upon introduction by Chairman Watson the following resolution prepared by the CSA Executive Committee was read and approved for adoption.

The CSA Executive Committee re[illegible]ves that a Safety & Environmental Health Department or Division be established at all college and university campuses and reporting to a Senior Administrative Officer. It is the opinion of the CSA Executive Board that all phases of Environmental Health should be placed under a director or officer to supervise areas of Safety, Sanitation, Industrial Hygiene, Radiation Protection, Fire Protection, Occupational Safety and Liability Insurance Programs. A survey of major universities throughout the nation has indicated that bringing together all aspects of EH & S provides the most efficient and economic operation of the overall program.

MOTION-CARRIED

Ken Licht recommended that this new resolution be sent to the School and College Conference of NSC for their information and endorsement.

ON MOTION - It was recommended to Ken Licht that CSA members be appointed to the School and College Conference.

Ray Ketchmark - reiterated to Ken Licht that representatives from CSA be placed on the Executive Committee of the School and College Conference even to the extent that they might have to displace some memberships from other groups.

MOTION-CARRIED

Chairman Watson then appointed Ray Ketchmark, John Morris, and Marvin Wells to be representatives to the School and College Conference.

Concerning a CSA statement of safety policy, the Executive Committee recommended that a proposed policy for safety and Environmental Health be introduced at a general meeting for general membership consideration and approval.

During the past 22 years the Campus Safety Association has developed through research and experience various Safety Programs that have been used as guides by many colleges and universities throughout the nation. We know that academic and administrative attitudes toward safety is one that is reflected and practiced by supervisors, faculty, department heads, staff, and campus personnel. As the basis for every safety program a statement of policy should be adopted by the Chief Executive Officer of the campus.

A guide for formulating such a safety policy is as follows:

The CSA Proposed Policy for Environmental Health and Safety:

The personal safety and health of faculty, staff, students and the visiting public is of primary concern to the University. Providing a safe environment in which to pursue innovative educational programs is of such consequence that it will be given top priority, support and implementation wherever necessary. To the greatest degree possible, a program shall be provided to reduce or completely eliminate incidents which cause injury to personnel, damage to property, fire or explosion, and hazards to health.

The president or the primary chief executive officer is responsible, and accepts full responsibility, for maintaining a safety and environmental health program. He is also responsible for it's leadership, for its effectiveness and improvement, and for providing the safeguards required to insure safe conditions.

MOTION-CARRIED

Ray Hall - Suggested that future business meetings be held somewhere in the middle of conferences to enable members to deliberate on any proposed legislation and better contribute ideas for the good of the association and the next conference.

Currently, members are almost forced to accept policies rather than be able to make any constructive criticism.

CSA Representatives that have attended various conferences during this past year were:

National Association of Colleges and Universities and Business Officers in New Orleans - Don Hadley

American Colleges and Health Associations - Victor Osborne

NFPA - John Fresina

American National Standard - A92 Mobile Scaffolds - Harry Mann

National Fire Protection in Chicago - Dick Giles

The Campus Safety Association should also consider promoting representation to the following organizations:

Association of Colleges and Housing Offices
Association of Physical Plants Administrators
Colleges and Universities Personnel Association
National Association of College and University Attorneys
University Insurance Members Association

Recommendation by Chairman - Mr. Oliver Halderson should be reimbursed for a trip to Maine to assist Mr. Clifford with reference to the 1976 Conference in Orono, Maine.

MOTION-CARRIED

Let Ollie or Mr. Clifford know topics of interest for the 1976 conference.

Thanks and appreciation were given to Ken Licht for the work he has done for 1975 Conference.

Chairman, William Watson steps down from his office. New Chairman for 1975-76 is Mr. Oliver Halderson.

Mr. Clifford requested and would greatly appreciate the assistance from all CSA members for the 1976 Conference.

Suggestions for New Committees: - Historical Committee:
John Hill
John Morris
Ray Ketchmark
George Harper

It was felt that past conference program chairmen would be of great assistance to the new host chairman in setting forth ideas and suggested guidelines for future programs.

Nominating Committee - William Watson

Ray Hall - CSA meets on September 30, 1975, Tuesday in Chicago also, October 1, 1975, Wednesday.

Names of Committee Heads will be published in Newsletter. They will remain the same and will be submitted by the past chairman.

The New Officers taking office today are:

Chairman - Oliver Halderson, Southern Illinois University, Carbondale, Illinois.
Vice Chairman - Ray Hall, University of Colorado, Boulder, Colorado
Corresponding Secretary - William Steinmetz, University of California, Santa Barbara, California
Recording Secretary - Frederic W. Thomas, Howard University, Washington, DC
Treasurer - James Knocke, University of Wisconsin, Madison, Wisconsin

Discussion on CSA Representation to other Organizations:

It was felt that the CSA should pay the registration fee at other conferences when a member is asked to represent CSA.

Registration Fee: On motion it was suggested to increase the registration fee to defray all incidental expenses. The Chairman recommended the registration fee be raised to $75.00.

MOTION-CARRIED

A sincere thanks and standing ovation was given to the Past Chairman for his services rendered.

Meeting adjourned 2:55 p.m. (post meridian).

Frederic W. Thomas
Recording Secretary

OTHER SAFETY MONOGRAPHS FOR SCHOOLS AND COLLEGES

(Monographs No. 1,2,3,5,6,13 and 16 are out of print and are available by loan only from the NSC Library.)

NO. 1 1952	EXPERIENCING SAFETY IN COLLEGE AND UNIVERSITY LIVING CENTERS. Personnel Section, American Association of Colleges for Teacher Education and the Higher Education Committee, National Safety Council.
NO. 2 1954	FIRST NATIONAL CONFERENCE ON CAMPUS SAFETY. University of Illinois and National Safety Council.
NO. 3 1955	SURVEY OF ACCIDENTS TO COLLEGE STUDENTS. American College Health Association and the National Safety Council.
NO. 4 1955	SECOND NATIONAL CONFERENCE ON CAMPUS SAFETY. University of Minnesota and the National Safety Council. $1.80. Stock No. 429.50-4.
NO. 5 1956	ACCIDENTS TO COLLEGE STUDENTS. American College Health Association and the National Safety Council.
NO. 6 1956	THIRD NATIONAL CONFERENCE ON CAMPUS SAFETY. Massachusetts Institute of Technology and the National Safety Council.
NO. 7 1957	FOURTH NATIONAL CONFERENCE ON CAMPUS SAFETY. Purdue University and the National Safety Council. $1.80. Stock No. 429.50-7.
NO. 8 1958	FIFTH NATIONAL CONFERENCE ON CAMPUS SAFETY. California Institute of Technology and the National Safety Council. $1.80. Stock No. 429.50-8.
NO. 9 1959	SIXTH NATIONAL CONFERENCE ON CAMPUS SAFETY. Michigan State University and the National Safety Council. $1.80. Stock No. 429.50-9.
NO. 10 1960	SEVENTH NATIONAL CONFERENCE ON CAMPUS SAFETY. Cornell University and the National Safety Council. $1.80. Stock No. 429.50-10.
NO. 11 1961	THE BICYCLE AND THE MOTOR SCOOTER ON THE COLLEGE CAMPUS. Michigan State University, the University of Washington and the National Safety Council. $1.25. Stock No. 429.50-11.
NO. 12 1961	EIGHTH NATIONAL CONFERENCE ON CAMPUS SAFETY. Southern Illinois University and the National Safety Council. $1.80. Stock No. 429.50-12.
NO. 13 1962	ORGANIZATIONAL STATUS AND DUTIES OF CAMPUS SAFETY PERSONNEL. Los Angeles City School System and the National Safety Council.
NO. 14 1962	INJURIES IN MEN'S PHYSICAL EDUCATION AND INTRAMURAL SPORTS. Michigan State University and the National Safety Council. $1.80. Stock No. 429.50-14.
NO. 15 1962	SAFETY EDUCATION LAWS AND REGULATIONS. State University of New York and the National Safety Council. $1.25. Stock No. 429.50-15.
NO. 16 1962	NINTH NATIONAL CONFERENCE ON CAMPUS SAFETY. University of California at Berkeley and the National Safety Council.
NO. 17 1963	TEACHER PREPARATION AND CERTIFICATION IN DRIVER EDUCATION. Illinois State University, Iowa State University and the National Safety Council. $1.25. Stock No. 429.50-17.

NO. 18 1963	TENTH NATIONAL CONFERENCE ON CAMPUS SAFETY. Indiana University and the National Safety Council. $1.80. Stock No. 429.50-18.
NO. 19 1964	ELEVENTH NATIONAL CONFERENCE ON CAMPUS SAFETY. Rutgers University and the National Safety Council. $1.80. Stock No. 429.50-19.
NO. 20 1965	TWELFTH NATIONAL CONFERENCE ON CAMPUS SAFETY. Central Michigan University and the National Safety Council. $1.80. Stock No. 429.50-20.
NO. 21 1966	THIRTEENTH NATIONAL CONFERENCE ON CAMPUS SAFETY. University of Washington and the National Safety Council. $1.80. Stock No. 429.50-21.
NO. 22 1966	SEMINAR FOR SAFETY EDUCATION SUPERVISORS. Indiana University, Insurance Institute for Highway Safety and the National Safety Council. $1.25. Stock No. 429.50-22.
NO. 23 1967	FOURTEENTH NATIONAL CONFERENCE ON CAMPUS SAFETY. University of Nebraska and the National Safety Council. $1.80. Stock No. 429.50-23.
NO. 24 1967	COLLEGES AND UNIVERSITIES HIGHWAY TRAFFIC AND SAFETY CENTERS. College and University Safety Centers, Division of Higher Education Section, National Safety Council. $1.25. Stock No. 429.50-24.
NO. 25 1968	FIFTEENTH NATIONAL CONFERENCE ON CAMPUS SAFETY. University of Vermont and the National Safety Council. $1.80. Stock No. 429.50-25.
NO. 26 1969	SIXTEENTH NATIONAL CONFERENCE ON CAMPUS SAFETY. Texas A & M University and the National Safety Council. $1.80. Stock No. 429.50-26.
NO. 27 1970	SEVENTEENTH NATIONAL CONFERENCE ON CAMPUS SAFETY. University of California at Santa Barbara and the National Safety Council. $1.80. Stock No. 429.50-27.
NO. 28 1971	EIGHTEENTH NATIONAL CONFERENCE ON CAMPUS SAFETY. University of Illinois at Chicago Circle Campus and the National Safety Council. $3.50. Stock No. 429.50-28.
NO. 29 1971	NATIONAL SAFETY EDUCATION CURRICULUM GUIDELINES (K-6). Indiana University at Bloomington and the Elementary School Section of the National Safety Council. $3.50. Stock No. 429.50-29.
NO. 31 1972	SAFETY IN K-6 STUNTS AND TUMBLING. Author, Miss Victoria Benedict. $3.50. Stock No. 429.50-31.
NO. 32 1972	NINETEENTH NATIONAL CONFERENCE ON CAMPUS SAFETY. Brown University and the National Safety Council. $3.50. Stock No. 429.50-32
NO. 33 1973	TWENTIETH NATIONAL CONFERENCE ON CAMPUS SAFETY. Colorado State University and the National Safety Council. $3.50. Stock No. 429.50-33.
NO. 34 1974	TWENTY-FIRST NATIONAL CONFERENCE ON CAMPUS SAFETY. University of California-Davis and the National Safety Council. $3.70. Stock No. 429.50-34.
NO. 35 1975	TWENTY-SECOND NATIONAL CONFERENCE ON CAMPUS SAFETY. University of Calgary at Alberta, Canada and the National Safety Council. $5.00. Stock No. 429.50-35.

Beginning with Monograph (1971) No. 28, the series was renamed to include Schools--Safety Monographs for School and Colleges.

Except for sale items (all Monographs-1966 and prior-$1.00 ea.) Prices subject to 20% discount to NSC Members. For quantity prices write Order Dept., National Safety Council. Specify complete title and Stock No. Payment must accompany orders for $5.00 or less.